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ABSTRACT

The document reports the development of three pre-entry criterion--referenced tests (Skill Checks) designed to assess an applicant's verbal and numerical competencies and to assist in the implementation of remedial education where needed, in the vocational training areas of office occupations, automotive mechanics, and machine shop. A general matrix of competencies for the three training areas was established through analysis of course content in terms of reading level of material used, numerical skills needed, and student and instructor perceptions of skills necessary to complete a course successfully. These were developed into Skill Checks which underwent field testing, item analysis, measurement of validity, and evaluation in order to determine their usefulness as predictors of student success and need for remediation. A flow chart visually outlines test development procedure. Continuation of the project is planned with six new areas for test development and the co-operation of other institutions anticipated. It is felt that immediate identification of skill deficiencies and their remediation, through Skill Checks, will help students to complete their vocational programs successfully. A bibliography, a third party evaluation of the project, and the office occupations, automotive mechanics, and machine shop tests are appended. (LH)

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FINAL REPORT
VOCATIONAL EDUCATION PROJECT
#75-5110(125)08

DEVELOPMENT OF AN INSTRUMENT FOR PRESCRIBING COMPENSATORY EDUCATION FOR VOCATIONAL TRAINEES

RENTON SCHOOL DISTRICT
RENTON, WASHINGTON

JUNE 1975

RESEARCH COORDINATING UNIT
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COMMISSION FOR VOCATIONAL EDUCATION

RESEARCH COORDINATING UNIT

ABSTRACT

Renton Vocational Technical Institute received funding for a special project entitled "Development of an Instrument For Prescribing Compensatory Education For Vocational Technical Trainees", Project 75-5110 (125) 08, to develop three pre-entry criterion-referenced tests (Skills Checks). These Skills Checks are designed 1) to assess an applicant's verbal and numerical competencies which are identified as prerequisites to successful training in the applicant's vocational area; and 2) to assist in implementation of remedial education based on deficiencies identified by the Skills Checks. This goal of developing three pre-entry criterion-referenced Skills Checks has been achieved.

Skills Checks have been developed for vocational training areas of Office Occupations, Automotive Mechanics and Machine Shop. All Skills Checks have undergone field testing, item analysis, measures of validity (when possible) and evaluation by the Third Party Evaluator, Dr. Charles Schultz. The Skills Checks are being administered to all applicants to these vocational training areas as part of the application procedure of the Institution. Those applicants demonstrating skill deficiencies are being provided with appropriate remediation.

The first year of the development of Skills Checks has generated interest and support from students and staff at Renton Vocational Technical Institute and in other vocational training programs throughout the state. Based on verbalized interest, the project applied for a continuation grant for FY 76. Funding was granted to the continuation proposal. It is anticipated that during the continuation year, the project will develop an additional six Skills Checks in other vocational training areas at Renton Vocational Technical Institute, and an additional four Skills Checks in subjects offered through other vocational training programs. It is expected that

the Research Assistant will work in close cooperation with individuals from other institutions in order to familiarize them with the operation of the Skills Check program. It is anticipated that this cooperation with other training programs will encourage modifications in the project which will increase its generalized applicability throughout the state of Washington.

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STATEMENT OF PROBLEM

The recent emergence and rapid growth of vocational training institutions has given rise to a number of critical problems relating to evaluation and guidance of applicants. Often applicants do not have sufficient preparation to begin training in a vocational program. Yet, due to an "open-door" policy, they are admitted. One of the consequences of this situation is that several students, upon entering vocational programs, discover that they are incapable of doing the required work, begin to flounder, become frustrated and begin to be tardy, absent, and eventually drop-out. Attendance records echo this pattern over and over again.

Vocational training institutions have not ignored this problem. They recognize the need for applicants to possess adequate prerequisite skills and knowledge prior to enrollment. Typically, applicants are characterized by a wide range of aptitudes, interests, and achievements. The need to assess aptitudes and achievements in some rational manner has led to the development of instruments and techniques designed to either screen out persons exhibiting deficiencies or to identify them so that compensatory instruction can be provided.

Insight into individual strengths and weaknesses has been sought through an examination of background data, interviews, and standardized tests. Efforts in the latter instance have been hampered seriously by the failure of existing instruments to meet three conditions: (1) contain items relevant to vocational technical instruction, (2) appeal to young and older adults, and (3) contain items that are not prejudicial to applicants in that they are culturally laden and/or heavily reliant on verbal skills.

This lack of standardized instruments appropriate to diagnosing an applicant's deficiencies or to predicting trainee success has led to a number of situations. Some training agencies simply do not use tests while others knowingly misuse measuring instruments. A few agencies seek empirical combinations of measurements of individual traits and separate factors of intelligence into instruments designed and weighted to predict success in specific areas of training within their institutions.

While no one familiar with current psychological research can argue against trait and factor theory as a basis of selection, it should not be the only criterion. As Raymond Ross points out, "Information on personal characteristics as they relate to various career choice options is a necessary but not sufficient condition for optimizing career development" (4:73). The central underlying assumption of this project is that if the real concern of vocational educators is to admit all adults and help them successfully complete training, attention must be directed to identifying achievement level. Identification must be in such a manner as to allow the systematic remediation of relevant learning deficiencies through prescribed compensatory training activities conducted either prior to or concurrent with job training.

This project's ultimate objective is the development of tests (hereafter referred to as Skills Checks) for specific vocational training areas. Skills Checks would be comprised of items relevant only to a particular training program. Only skills defined as necessary prerequisites would be measured. Information supplied by a Skills Check would permit vocational technical institutes and community colleges to assess and compare an applicant's achievement level with the level determined as necessary for entrance and successful participation in the applicant's chosen vocational area. Persons exhibiting deficiencies in areas for which they request vocational training would be encouraged to receive relevant compensatory instruction.

It is anticipated that successful identification of skill deficiencies and remediation of those skills will result in reduced rates of tardiness, absenteeism and unscheduled withdrawals. Successful completions of vocational programs are expected to increase.

Utilizing the principles of criterion-referenced testing, (see Criterion-referenced Testing Section), this project's ultimate goals are to:

Develop Skills Checks that identify those students demonstrating insufficient competency in one or more skills.

Develop Skills Checks that will provide information for prescriptive remedial education, causing instruction to consist of only those skills necessary for participation in a given occupational area.

Design Skills Checks in a manner that will allow application to vocational programs throughout Washington State.

OBJECTIVE

To increase the percentage of students who successfully complete vocational training programs as a result of the development and implementation of pre-entry criterion-referenced Skills Checks and remedial education programs which are based on such Skills Checks at Renton Vocational Technical Institute from the current estimate of no students tested per selected class to all potential enrollees per selected class by June 30, 1975.

Specific Objectives

1. Select project staff.
2. Complete a thorough review of the literature by the Research Assistant.
3. Identify basic entry-level verbal-numerical skills required for success in three selected vocational training programs.
4. Develop test instruments which will test basic skills relevant to the three selected vocational training programs. These tests will be administered to all applicants for each vocational training program.
5. Prescribe specific remedial instruction in areas of demonstrated weakness.
6. Provide the prescribed instruction for a minimum of ten persons in each of the three training areas.
7. Assess the effectiveness of the prescribed instruction by analyzing the rate of success of those students who receive compensatory instruction and subsequently enter and remain in vocational training programs.
8. Prepare final report.

A brief schedule for completion of the above objectives is given on the following page.

TIME LINE

October	1. Selection of project staff 2. Review of literature 3. Identification of course areas to be utilized
November, December	1. Analysis of course content 2. Development of rough draft of course tests
January	1. Field test of rough draft of tests 2. Individuals for case studies identified
February, March	1. Remediation provided 2. Case studies begun 3. Tests evaluated
April, May	1. Tests revised, utilized, and evaluated 2. Subsequent performance in vocational training areas of those students who have received remedial education observed
June	Final report prepared

STAFF

Project Director

Dr. Robert C. Roberts
Assistant Superintendent, Renton School District #403
Administrative Director, Renton Vocational Technical Institute
3000 Northeast 4th Street
Renton, WA 98055

Project Assignment

The Project Director is responsible for satisfactory completion of the project. While not involved in the daily conduct of the project he provides general guidance for project direction and staff cooperation.

Principal Investigator

Delight C. Willing
Coordinator: Supplemental Support Services
Renton Vocational Technical Institute
3000 Northeast 4th Street
Renton, WA 98055

Background: B.A. - Carlton College, Teaching Certificate-
Ottawa College, M.A. (July '75) - Seattle Univ.

Project Assignment

The Principal Investigator will insure that scheduled project activities are conducted in accordance with the project plan. It is estimated that 440 hours will be required for this task. The Principal Investigator will accomplish the following specific tasks:

1. Selection of other project staff.
2. Supervision of review of the literature.
3. Supervision of the training areas to be used for the research project.
4. Supervision of the analysis of the course content of the selected vocational training areas.
5. Supervision of the development of the specific matrix of competencies for each selected vocational training area.
6. Supervision of test development.
7. Supervision of field test.
8. Supervision of identification of individuals for case studies.
9. Prescription of specific remedial instruction in areas of weakness for identified individuals.
10. Supervision of remedial education.
11. Supervision of case study preparation.
12. Supervision of test review and revision.
13. Supervision of the preparation of the final report.

Research Assistant

Craig Mueller
Research Assistant
Renton Vocational Technical Institute
3000 Northeast 4th Street
Renton, WA 98055

Background: B. A. - Univ. of Washington, M.A. - Western Wash. State College

Project Assignment

The Research Assistant will conduct much of the research and maintain the records for the project. It is anticipated that the Research Assistant will have background in testing, through courses in education, psychology, or sociology. In addition, the Research Assistant will be expected to maintain detailed records during the duration of the project to be utilized in preparation of a complete final report. The Research Assistant will accomplish the following specific tasks:

1. Conduct review of literature.
2. Become familiar with criterion-referenced testing, readability analyses, performance objectives, and other methods of course content analysis.
3. Analysis of the course content of the selected vocational training areas.
4. Development of the specific matrix of competencies for each selected vocational training area.
5. Development of specific criterion-referenced tests.
6. Conduct of field test of tests developed, including actual testing of prospective vocational trainees, test scoring, and test analysis.
7. Identification and recommendation of individuals for case studies.
8. Preparation of individual case studies.
9. Completion of test review and revision.
10. Preparation of the final report.

Third Party Evaluator

Dr. Charles Schultz
Supervisor - Examination Standards
Washington State Dept. of Personnel
600 S. Franklin St.
Olympia, WA 98501

Background: B.S. M.S. Ph.D. - Univ. of Washington

Project Assignment

1. Provide continuous evaluation of project progress through critical review and redirection in following areas:
    - A. Development of measurement objectives
        1. Design of content analysis methods
            - a. Review of curriculum material
            - b. Interview of instructor, students
            - c. Observation of problem areas
        2. Avoidance of irrelevant content
    - B. Review of Test Segments
        1. Item construction
        2. Balance of item in a test (length of segments)
    - C. Reliability
        1. Methods for building in reliability
        2. Methods for assessing reliability
    - D. Validity
        1. Content validity
            - a. Evaluation of content domain definition
            - b. Adequacy of test as measure of domain
        2. Empirical validity
            - a. Value of the test in improving performance
            - b. Quasi-experimental design
    - E. Test Characteristics
        1. Interpretation of test scores
        2. Usefulness for diagnostic testing

II. Prepare evaluation of final report, to be attached to Project Final Report, ascertaining degree of success with which project met its objectives.

DISSEMINATION

The final report, to be prepared as part of the continuation project, will be transmitted to vocational technical institutes, community colleges, and other significant institutions in the Washington vocational delivery system. It is expected that interest will be such as to warrant the conduct of several short-term workshops. If so, funds will be requested through the Research Coordinating Unit for this inservice training. These services will be provided by June, 1976.

Plans call for the development of a non-technical report to be submitted for publication to several journals that are widely read by vocational educators.

REVIEW OF THE LITERATURE

A review of the literature was carried out to familiarize project staff with current research and to locate any research which would make this project seem redundant. The review included a search of the ERIC files from 1967 to the present, using the following descriptors:

Vocational Aptitude
Vocational Counseling
Vocational Development
Vocational Education
Adult Vocational Testing

The literature review revealed that administrators, counselors, and educators have expended much energy attempting to obtain reliable vocational guidance information. It was observed that regardless of whether interests ran from "self-concept" (Brian: 1973), (Worthington:1973) to "student autonomy in decision-making" (Richardville:1972), practitioners overwhelmingly relied upon standardized aptitude-type instruments. Even when sought information required knowledge of an applicant's competencies, aptitude or combinations of aptitude-achievement type instruments were used. The overwhelming majority of sources dealt with the aptitude and interest tests; little mention was made of assessments of cognitive knowledge as related to success in vocational training. Sources that were orientated toward cognitive knowledge (achievement) usually dealt with post-training measures of competency and relationship to occupational success.

Since so many of the materials reviewed focus upon aptitude and interest testing, perhaps a note on the difference between aptitude and achievement tests is appropriate here. The difference between achievement and aptitude testing is a difference in the degree of uniformity of relevant antecedent experience.

Achievement tests measure the effects of relatively standardized sets of experiences. While aptitude tests measure the effects of learning under relatively uncontrolled and unknown conditions, achievement tests measure the effects of learning that occurred under partially known and controlled conditions.

Aptitude tests serve to predict subsequent performance. Achievement tests represent an evaluation of the individual's status upon the completion of training, or current level of knowledge. Of course, an achievement test can be used as a predictor when different individuals have had the same or closely similar courses of study.

When achievement tests are employed in placement and classification, attention must be given to trait difference. For this reason, the use of achievement tests in different areas has been advocated. Achievement tests are useful in the identification of pupils with special educational disabilities and in the measurement of progress in the course of remedial work. (Note: This material is based on the work of Anne Anastasi.)

One source that had objectives similar to this project's was... "Minnesota Vocational Interest Inventory Training Success Norms" by David Pucel and Howard Nelson. This article is one of several to come out of Project MINI-SCORE. The authors point out the need to identify basic competencies and selected characteristics which would be useful to counselors and others in the counseling of vocational-technical orientated students as they seek to pursue specific vocational-technical curricula. The authors rely upon the Minnesota Vocational Interest Inventory (MVII)... an instrument composed of 158 triads of brief statements describing the tasks or activities involved in a number of different occupations. It is at the point of instrument selection that similarities between this article and project stop. The MVII is designed in a manner that combines basic competencies and selected characteristics into interest patterns. So what the authors are actually dealing with and measuring are the underlying interests of applicants. The interest patterns of successful vocational graduates were measured to form a norm by which an applicant's interest pattern is compared. If an applicant's interest pattern fell noticeably out of the normative pattern the applicant could be advised that this particular program may not be suitable. This type of assessment relies upon the standardized testing approach to securing information, ignoring the fact that the applicant may or may not have appropriate skills. This source is typical of many of the interest-orientated projects designed to provide information for decision-making. Directing himself to literature dealing with vocational interest inventories, Osipow in Karl Kuze's "Overview of Needs, Programs and Implementations of Vocational Counseling and Guidance" states, "There is a tendency in our culture to make choices consistent with interest and hope or even assume that abilities will prove to be adequate when, in fact, most of the data indicate or lead to inference that abilities far override interests in influencing vocational attainment" (Kuze 2:70).

There is also the methodological problem of ignoring, over time, changes in interest. It seems unreasonable to compare an applicant's interest with a tradesman's interest. A tradesman has undergone extensive training which could easily effect and change interests. Were the interests the same at graduation as at application? What were the interest patterns of successful vocational graduates when they applied vs. when they graduated and began work? If there is no significant difference, one might suspect interest patterns at application would be more reliable and commensurate with counseling an applicant since these interest patterns would illuminate the initial interests that correlate highly with success in program and occupation.

Dr. Margaret Crawford also expresses an interest in assessing an applicant's competencies for placement into suitable occupational training areas. In her article, "Selection and Guidance of Students for Technical and Vocational Education" Dr. Crawford describes the development of an aptitude test battery that is currently in use at Los Angeles Trade-Technical College. The battery is a combination of personality and ability criterion usually measured separately by different standardized tests. The reliance of an aptitude-type test battery to obtain information about abilities is common throughout the literature. Dr. Crawford has found fault with this test battery. She states, "A further problem is the subjective nature of the personality test combined and high weightings of these variables in a battery caused by the low intercorrelation between personality test scores and ability scores. We need to use caution in these areas. Vocational nursing is a good example of this problem. Many studies of nursing aptitudes show strong correlations with the theoretical part of the occupation but little correlation with work in the wards. Nursing examinations are highly verbal and tend to stress reading comprehension and academic abilities" (Crawford 16:66).

By this statement, Dr. Crawford points out the following: 1) The problem of standardized items being culturally laden or heavily reliant on verbal skills, 2) The inadequacy of combining tests into an aptitude test battery to assess abilities, 3) The need for instruments to better assess abilities in relationship to job-related work. This project speaks directly to these issues.

The logic of this project was met in "Basic Skills for Health Occupations, Health Service Aide" by Dade County Public Schools, Miami, Florida. Dade County Public Schools has designed a 45 hour, no-credit course to provide selected beginning assistants in Health Occupations with initial skills and background information. Each student is provided with classroom experience in basic fundamental and manipulative skills applicable to all health services. Although the logic is similar, there are other factors which make this article non-amenable to this project's needs. There is no mention as to how students are selected for this special pre-program course. Whether admission is voluntary, involuntary, or based on skill deficiencies is unknown. Dade County is fortunate in being able to set up one program providing basic skills applicable to several related occupations. The typical vocational training center is represented by a diversity of occupations, each requiring different pre-entry competencies.

This article is the only one reviewed that dealt specifically with the need and means of providing training in basic competencies before a student began actual training. Unfortunately the success of the course could not be assessed because, at this point in time, there was no follow-up comparing students who went through the pre-program course with students who did not.

The need for performance tests for vocational placement is underlined in "Predictive Testing for Entrance in Vocational-Technical Schools" by John Miller. This study focuses on validity of prediction of success-type tests in vocational areas of machine shop and electrical wiring. The type of tests developed by Miller were problem situations set up to resemble everyday situations that tradesmen must be able to handle. The predictive value of these tests was very high, but this could have been due to the population tested. All applicants tested had had previous training in these areas in high school.

Although these tests seem to depart from this project by assessing more than basic pre-entry skills, i.e., skills taught in class, the author is asking a very important question that is usually neglected. Does the applicant have skills to do the required coursework?

Another source that advocated performance tests for vocational placement was "Rationale For and Development of a Battery of Performance Tests for Vocational Students", by William A. McLaurin, and others. However, the instrument designed to measure performance appears to be largely numerical in content. In its conclusion, this article points out that ".. it is further recognized that in many training programs much of the training material is highly verbal in nature. However, if an applicant can demonstrate the basic aptitudes required for success in an occupation, modification of training programs would be justifiable and advisable" (McLaurin 16,17:70)

This suggestion of modifying training programs brings about questions of: Given an applicant has the appropriate aptitude but is verbally deficient, how is this deficiency to be identified and remediated in a manner appropriate to the training area? How are the skills required for the success to be identified and remediated without requiring the student to study extraneous materials? These are questions that the project will attempt to resolve.

Thus, the Review of the Literature demonstrated that in no ways were this project's objectives duplicated. Throughout the literature there was expressed concern and need for vocational guidance and placement information. It was observed that interest usually was directed by questions about an applicant's aptitudes or competencies other than pre-entry skills. Seldom was the question asked, does the applicant have the necessary skills to begin coursework? When it seemed prerequisite skills were to be dealt with, invariably, there would be reliance upon standardized, aptitude-type instruments. It is imperative that practioners realize that instruments are designed to answer specific questions and meet specific needs. Using an instrument to answer questions and meet needs for which it was not designed constitutes a misuse of that instrument and results in inadequate information.

In review this project directs itself to the following questions:

What are the pre-entry skills necessary for successful participation in a given vocational program?

How are necessary pre-entry skills to be identified?

How are deficiencies and necessary remediation to be identified?

This project directs itself to these basic questions. If successful, the resulting developed instrument of this project will provide much needed information for counseling guidance, and placement of vocational applicants.

CRITERION-REFERENCED TESTING

Katz brings to front an important element in vocational training. "Vocational development may be a continuous process, but... the process is enacted through a sequence of choices" (8:1966). All vocational careers require decision-making on the part of the student, counselors, and vocational educators. Adequate decision-making requires reliable and valid information. Selecting a method for obtaining information is analagous to a mechanic selecting the tool best suited to do the job. With regard to this project, there are two tools one can choose from.... standardized tests or criterion-referenced tests.

As mentioned, there has been a great reliance placed upon standardized tests to provide information for counseling and guidance. Recently, examiners, counselors and educators have leveled additional criticism at the standardized approach to testing. The common complaint is that there is a need for certain types of information that standardized tests are incapable of providing. John Fremer states, "People want something more than they have been getting. A common theme in the requests for something more is that test users want more information that will be useful in making decisions" (Fremer 1:73).

Prediger, in an article, "Converting Test Data to Counseling Information" speaks of bridges between data and information. Because standardized tests usually rely upon national averages for individual score interpretation, he refers to standardized test data as a norm bridge. He states, "The norm bridge is an incomplete bridge since test norms simply permit one to estimate standing in some group and do not, per se, indicate the implications of this standing" (Prediger 2:71). Klein also lends support to the need for a new approach to testing. "Comparatively little help has been given to the classroom teacher to diagnose individual student needs" (Klein 1:73). Issues of accountability or what does a student know in terms of instructional objectives are often ignored. In reaction to this growing criticism a new form of testing has evolved...Criterion-referenced testing. Unlike Standardized tests, this form of testing usually does not use national averages or comparison of position in a range as correlates of score interpretation. In a recent paper, "Standardized vs. Criterion-referenced Testing", Burdette Hansen aptly points out similarities and differences of the two testing forms. Listed below are issues one should be familiar with before designing a test to meet particular information needs.

The two forms are similar in that both adhere to a base of educational objectives. However, standardized test objectives are based on what the majority of schools or institutions throughout the nation are attempting to achieve. Using a standardized form entails the assumption that objectives based on national norms met a particular institution's needs... i.e., objectives are similar. If this assumption is unreasonable, criterion-referenced is probably the better form. "Criterion-referenced tests are usually built around the school's own objectives" (Hansen 19:74).

Interpretation of scores received by examinees differ according to what form is used. With standardized tests, a raw score is converted into a standard score based on a national norm. Standard scores are placed on a bell-shaped curve for evaluation of achievement. This practice results in the placement of fifty percent of the tested population above the average student and fifty percent below. Outcome is more dependent upon method of scoring rather than actual scores. Results of criterion-referenced tests tend to ignore national standards and bell-shaped reporting schemes. "A criterion-referenced measure is essentially one that is deliberately constructed so as to yield measurements that are directly interpretable in terms of specified performance standards" (Klein 1:73)...Hansen points out that reporting in terms of the specific objective being measured makes it a simple task for a classroom teacher to determine whether or not the student knows the objective being measured (Hansen:1974).

Thus, there are two important differences between standardized and criterion-referenced forms. (1) Standardized tests are comprised of items designed to measure objectives generalized across populations and institutions.[1] Items for criterion-referenced tests are designed to measure objectives specific to particular populations and institutions. (2) Standardized scoring reports where a student places in relation to all other persons who took the test. Criterion-referenced scoring is not concerned with the relative position of a student with his peer group, but directs itself to the question... does the student know the material?

Since the project's objective is to develop tests that will provide information about an applicant's ability to perform prerequisite skills specific to a particular vocational program, a criterion-referenced approach was adopted.

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1. There are some instances of standardized tests failing to generalize measurability across populations. In particular, David Pucel in "The Ability of Standardized Test Instruments to Predict Training Success and Employment Success" used six instruments...General Aptitude Test Battery, Minnesota Vocational Interest Survey, Sixteen Personality Factor Questionnaires, Minnesota Importance Questionnaire, Vocational Development Inventory, and Minnesota Scholastic Aptitude Tests to measure criteria across six populations. He found, "None of the instruments were consistently most highly correlated with the same criteria across all three total populations on the six curriculum populations. The relationship between an instrument and the criteria changed from population to population, implying that an instrument that might be most effective in predicting a criterion in one population may not be the most effective in predicting that same criterion in another population." (Pucel 2:72).

METHODOLOGY OVERVIEW

1. The first task required the Principal Investigator to assemble a staff composed of a Research Assistant and a third-party evaluator. (See Staff section for project assignments).
2. Upon selection of the Research Assistant, a thorough review of the literature was carried out. The initial proposal was based upon the assumption that the review would not locate any research which would make the project seem redundant. This assumption was substantiated.
3. Three of the five traditional training service areas that are common to a majority of the vocational technical institutes and community colleges in the state of Washington were identified as subjects for this project.
4. An analysis of course content for the selected vocational training areas was carried out. The analysis included readability studies on all materials used in the course in order to ascertain the average reading level assumed. Numerical skills presupposed in the course content were analyzed by an item analysis. In addition to analysis of materials, instructors and students were interviewed to determine levels of knowledge presupposed in instructional content, and student perception of what they considered to be necessary pre-entry skills.
5. A general matrix of competencies for each selected vocational training area was established by the project staff and reviewed by the instructional staff.
6. Specific Skills Checks, utilizing the course matrices developed, were developed for each selected vocational training area. Skills Checks were composed of specific criterion-referenced items designed to evaluate an applicant's verbal-numerical skills in relation to the course

matrix. Items utilized subject matter drawn from a specific vocational training area.

7. The Skills Checks developed were field tested on all applicants to each selected vocational training program.

8. When specific deficiencies were demonstrated through performance on the test, the Project Director prescribed specific remedial instruction in areas of weakness. If deficiencies proved to be great, the applicant was requested to master educational objectives before entry into the vocational training program. If deficiencies were minor, such remedial education took place concurrent with vocational training. If weaknesses were great and the student was not receptive to remedial education, the Project Director and vocational counselor had the option of suggesting alternative vocational training programs which appeared more congruent with the applicant's verbal-numerical skills.

9. Originally, the project staff was to identify at least ten students who demonstrated specific weaknesses among those tested in each of the selected vocational areas. Detailed case studies involving progress reports on remediation performance and subsequent performance in the vocational training area were to be maintained. Unfortunately, the project began after the beginning of the school year. Skills Checks were administered three months after classes began, making an over-time study impossible. There was no realistic method available to assess the relationship between remediation performance and subsequent performance in the vocational training area. However, on the basis of pre-test results, six students in Office Occupations and twelve students in Automotive Mechanics were identified as having specific deficiencies and were given remediation. At this point in time feedback is not available to adequately assess results.

Since the project has been refunded, the project staff has made preparations to meet the above objectives as originally outlined. Applicants to Office Occupations, Automotive Mechanics, and Machine Shop are all being tested as part of the application procedure. At this time, twelve Office Occupations applicants have been identified as having skill deficiencies and are currently involved in remediation. Case studies, progress reports on remediation and subsequent performance in the vocational training area will all be included in the June 1976 final report.

10. After all Skills Checks had been field tested and remedial education implemented, the Skills Checks were thoroughly reviewed and analyzed by the project staff and the vocational instructional staff. Appropriate revisions were made and final forms of the Skills Checks were prepared.

11. A final report will be prepared.

SELECTION OF VOCATIONAL AREAS

The three vocational training service areas which were selected as subjects for this project were: Office Occupations, Automotive Mechanics and Machine Shop. All three vocational areas met project criterion of commonality to a majority of the vocational institutes and community colleges in the State of Washington.

DEVELOPMENT OF SKILLS LIST

Upon identification of each vocational area for test development, the following procedure was utilized in the development of the skills tests.

The determination and development of a pre-entry skills list requires three basic steps. First, the researcher performs a content analysis of all textbooks used in the selected program. The content analysis allows the researcher to become familiar with course requirements and expectancy levels regarding skills a student should have prior to entry into the course. Expectancy levels are established by noting where the coursework begins. For instance, if math begins with fractions there is an underlying assumption that the student is proficient in basic math skills of addition, subtraction, multiplication and division. Also, there is probably an assumption of student familiarity with fractions, at least some knowledge as to what fractions are and their use. Readabilities are also performed on the textbooks to determine the level an entering student should be reading.

Step two requires interviews with all instructors involved with the selected program. The project's objectives are briefly explained to each instructor, especially project needs for pre-entry skills only. All interviews center around the question... What do you believe are the necessary basic skills for a student to have prior to entering into your program? It is believed open-ended, unstructured interviews tend to result in maximizing information and in establishing rapport with instructors. On the basis of instructor interviews a tenative pre-entry skills list is drawn up.

Step three requires interviews with several students enrolled in the selected program. Students are chosen on the basis of length of time in the program and grades. It is assumed that students with greater length of time in the program will be the ones most knowledgeable and opinionated as to what pre-entry skills are necessary. It is further assumed that all grade levels should be represented so that a range of experiences can be tapped. "A" and "B" type students are most likely to have sufficient preparatory background and to be able to relate what skills helped them the most.

Other students selected will have a deficient preparatory background and, on the basis of the problems they have had in class, be able to reveal what they consider necessary pre-entry skills. After developing three skill checks, these assumptions have proved to be warranted. A skills list is developed from data obtained from student interviews.

After all three steps have been completed, a comparision of the researcher's familiarity of course textbooks, skills list developed from instructors'interviews, and skills list developed from student interviews is made. This comparison acts as a check and balance system, for inconsistencies are easily noticed and demand explanation before a final list can be developed.

It has been our experience that most inconsistencies were due to instructors listing skills "taught in class" as desirable pre-entry skills. Despite repeated explanation of project objectives, several instructors interpreted the skills check as a "screening device". Renton Vocational Technical Institute sponsors an open-door policy. Due to this policy there are very few means available to the instructor to keep out undesirable applicants. If an avenue of rejection is taken by an instructor, he is often called upon to defend his action. The overall result is that many instructors are forced to admit some applicants into their class that they do not want.

By listing certain skills as pre-entry, i.e., listing alegebra or geometry as pre-entry skills when the course begins with fractions, the instructor is putting some "teeth" into the skills check which could restrict or discourage admission. It is contended that, in most cases, skills taught by the instructor in the classroom are not legitimate pre-entry skills. The skills check is not intentionally designed as a screening device.

After all variation of listed skills has been explained, a final skills list is drawn up.

OFFICE OCCUPATIONS SKILLS LIST

The Office Occupations skills list was derived from a content analysis of text books, unstructured interviews with three instructors and twelve students, and the Coordinator of Office Occupations. Instructors interviewed taught English, math, accounting and typing. Students interviewed represented a range from poor to excellent students. All instructor interviews centered around the question....What do you believe are the necessary skills for a student to have prior to entering the Office Occupation's program? Students were asked the same question. In addition they were also asked...What problems did you have or perceive others to have in Office Occupation's coursework?

Content Analysis

A content analysis of Office Occupations' textbooks revealed the necessity for an applicant to have skills in English and math. In order to do the coursework, knowledge of parts of speech, parts of a sentence, capitalization, and punctuation are necessary. An applicant must be able to perform basic calculations of addition, subtraction, division and multiplication of whole numbers, and work with fractions, decimals, and percentage. Readabilities suggest an applicant's reading level should be around tenth grade. It was learned that most of the above skills are taught in the classroom. Normally, these skills would not meet project needs because they fall in the category "skills taught in class". However, after interviewing the four Office Occupations' instructors it was determined that it would be reasonable to request applicants to have at least minimum proficiency in these skills.

Instructors interviewed argued that although they teach basic skills in English and math these skills should be pre-entry skills because of two factors. First, since most entering students do have some background in English and math, the introductory courses are taught with the underlying assumption that English and math skills are not new to students. Second, introductory courses are one semester in length. Combining the underlying assumption of previous experience and the time factor, one observes the consequence of some students falling behind, becoming defined as poor students and ending up either taking the course over again or dropping out. Instructors anticipate that if students entered office occupations with at least a minimal skill base the chances of failure or frustration would be significantly reduced. This logic was adopted in developing the final Office Occupations skills list.

INSTRUCTOR INTERVIEWS

Instructor I teaches English. She mentioned parts of speech, sentence construction and vocabulary as skills most problematic to students. Sentence construction is defined as parts of a sentence, i.e., subject, predicate and direct object. Other skills mentioned were capitalization, punctuation, word usage, spelling and reading. Vocabulary, spelling and reading skills should be at least at the ninth grade level. The instructor believes that if students enter Office Occupations with a skill base composed of the above they will have minimal difficulty.

Instructor II teaches accounting. He is looking for students with average intelligence which he defines as sophomore for older students and senior for younger. He wants people who like to work with figures. It is necessary to have basic skills of addition, subtraction, division and multiplication. Several students have been having problems with coursework which he relates to insufficient math background, classwork overload, not knowing how to study, and don't give a damn attitude. His attendance record was marked with several absences and tardies.

Instructor III teaches math and typing. Much of the interview was an echo of the previous two. She especially emphasized students having problems with decimal placement after addition, multiplication and division of decimals. "They simply don't know what to do with the decimal." Also, students must know fraction to decimal equivalents, percentage and percentage to decimal equivalent and decimal to percentage equivalent.

On the basis of instructor interviews the following list was constructed:

Identifying Parts of Speech

1. Nouns
2. Pronouns
3. Adjectives

4. Verbs
5. Adverbs
6. Prepositions
7. Conjunctions

Capitalization

8. First word of every sentence
9. Brand names
10. Building names
11. Business firms
12. Days, months
13. Historical events, periods, documents
14. Institutions
15. People
16. School terms
17. Title of publications
18. Places

Identifying Parts of Sentence

19. Subject
20. Object
21. Predicate

Punctuation

22. Quotation marks
23. Apostrophe
24. Period
25. Question mark
26. Exclamation point

Word Usage

27. Correct use of pronouns
28. Similar sounding words
29. Correct use of verbs

Spelling

30. Common words (20 words)

Vocabulary: Meaning of words

31. Approximate meaning (synonym) (25 words)

Reading

32. Comprehension

STUDENT INTERVIEWS

Student One: An older student (about 40-45 years of age), a very successful worker and ranked as an "A" student by the instructor. She has not had any problem with coursework but she did mention that punctuation did seem to be a problem with some of her peers, especially the use of the comma. Also, many students have problems with percentages, especially fractions to percentages since the machines they use will not make the conversion.

Student Two: Rated as a poor student by the instructor. She was a very cautious student, just becoming aware of her potential. All mathematical computations, percentages, decimals, parts of speech, use of comma and periods were problematic. The program has been extremely difficult for her. She wants to stay in the program but without remedial training it is unlikely she will succeed.

Students Three and Four were interviewed together. Both students were rated as slightly above average. They believe ability to add, subtract, divide and multiply are necessary skills for a student to have prior to entry and they have noticed that several students have problems with parts of speech

Student Five: Rated as a "C" student. She was very reclusive.. difficult to interview, but she did mention that she has had problems with percentages and converting fractions to decimals. She was not aware of any problems other students were having.

Student Six: A foreign student who was rated high in math but low in English. He stated that he had no problems with math, but English (not his native language) was a serious problem. Vocabulary, spelling and punctuation were his main problems. Basic calculations, fractions, decimals and percents were mentioned as necessary pre-entry skills.

Student Seven: Rated as "A" by the instructor. She had no problems herself but believed other students were having troubles with fractions, decimals and percentages. At this point she had not taken the English class and therefore was not familiar with particular English problems.

Student Eight: A "C" student who was unfamiliar with problems in English. Fractions, decimals and percentages were pointed out as problem areas. A problem that has frustrated her as well as others is that students are expected to learn how to use a machine with minimal instructions and mathematical processes at the same time. Many students have not used math for several years and being unfamiliar with adding machines makes it unnecessarily difficult. A math review prior to coursework would benefit many students.

Student Nine: A "C" student who was a beautician. She became discouraged with low pay, long hours and weekend work, and is now training for an office job. She has been away from school for 18 years.... has no problems with math but English is rather difficult. There is a definite need for basic mathematical skills and knowledge of fractions, decimals and percentages. Parts of speech is her problem area.

Student Ten: A "D" student originally from Alaska where she received inadequate training in math and English. She had enrolled in business occupation's English course, but was forced to drop the course after it proved to be difficult. On her own initiative she is taking an English review course. Other than a locator test she was not tested to see whether she had the skills to successfully participate in Office Occupations coursework.

Student Eleven: An older student rated "C" who once was a beautician and is now training for another job. She has experienced difficulty with math and has taken self-review courses. Basic computations are a weakness, especially multiplication. She has had no problems with English.

Student Twelve: A college student ranked "A", taking classes in Office Occupations. She believed all basic math and English skills were necessary for a student to have prior to entry. Four of her friends dropped out of RVTI's summer courses due to lack of appropriate skills necessary for course assignments. They also had become frustrated trying to learn how to operate adding machines while not fully understanding mathematical procedures.

At completion of student interviews a skills list was drawn up and compared with the skills list derived from instructor interviews. No inconsistencies were noted. However, an addition was necessary. Students mentioned the "use of comma" as a necessary prerequisite whereas instructors did not. Instructors were asked if "use of comma" was a justifiable pre-entry skill. They supported the skill and it was incorporated into the final list.

After the content analysis, interviews, and resulting skills list were completed, the Director of Office Occupations was requested to review and comment on our efforts. She was satisfied that the skills list included all pre-entry skills pertinent to Office Occupations. She was very supportive in all ways with the exception of some reservation about cover design. This will be worked out later.

The final skills list was the same as the one developed from instructor's interviews with the addition of the "Use of Comma" skill:

a) Separate words and numbers in a series
b) Set off an appositive

c) After a dependent clause at the beginning of a sentence
d) Before quotations
e) With addresses and dates
f) Set off such words as "of course, indeed, for instance, moreover, no doubt"
g) After introductory words which are separated from the rest of the sentence
h) Before a coordinating conjunction in a compound sentence

AUTOMOTIVE MECHANICS SKILLS LIST

The Automotive Mechanics skills list was derived from a content analysis of course textbooks, interviews with the three automotive instructors, and interviews with twelve students. Students were selected by the head instructor on the basis of "grades" and "length of time in the program".

Content Analysis

A content analysis of automotive mechanics' textbooks revealed that a student should have a working knowledge of basic math skills, fractions, decimals and some percentage. Readabilities rated textbook reading difficulty between 10.2 - 12.5. It was also noted that a student will be confronted with many new words. Without a mechanical background, vocabulary may prove to be a problem. Since these skills are not taught in the classroom, it is believed to be especially important for applicants to have some competency in these areas before entering the automotive program.

Instructor Interviews

There are three automotive mechanics instructors. All three were interviewed at the same time. The project's objectives were explained repeatedly because it was necessary to make sure the instructors understood that our project was not concerned with developing a screening device. Instructors were not satisfied with the caliber of several students and wanted a means of eliminating them or screening them out. After reaching an understanding, the instructors appeared very supportive. Some caution should still be exercised as to how they perceive the use of the proposed skills check. Their initial interpretation is excellent reason why skill check results should be interpreted and used by an objective or neutral party.

All three instructors agreed upon the following skills as necessary pre-entry skills:

Basic computations

1. Addition of whole numbers
2. Addition of money: dollar sign and decimal point
3. Subtraction of whole numbers
4. Subtraction of money using dollar sign and decimal
5. Multiplication of whole numbers
6. Multiplication of money using dollar sign and decimal point
7. Division of whole numbers
8. Division of money using dollar sign and decimal point
9. Computing averages

Fractions

10. Addition of fractions
11. Subtraction of fractions
12. Multiplication of fractions
13. Division of fractions
14. Reducing fractions
15. Unlike fractions
16. Fractions to decimals
17. Fractions to percent

Decimals

18. Reading and writing decimals as numbers and words
19. Addition of decimals
20. Subtraction of decimals
21. Multiplication of decimals
22. Division of decimals
23. Comparing decimals
24. Rounding off
25. Decimal to percent

Percentage

26. Percent to decimal
27. Percent of a total

Reading

28. Comprehension (with grade level)

Vocabulary

29. Approximate meaning (synonym)

Student Interviews

Student One: A "B" student who has been in the program since September 1974 mentioned basic computations, precentages, reading and comprehension as very important pre-entry skills. Reading was most important with desired reading level placed at twelfth grade. This student supported the need for a test because of so many students having trouble with shop and classroom problems.

Student Two: This student has been in the program for 1 1/2 years and is rated "one of the best" by instructors. Basic calculations, fractions, decimals, percentages, vocabulary and reading were all mentioned as important pre-entry skills. He also supported our project's objective.

Student Three: Student has been in the program for two years and is also rated "one of the best". His responses were the same as Student Two's. Basic computations, fractions, decimals, percentages, vocabulary and reading were all listed as necessary pre-entry skills.

Student Four: Ranked "C" by instructors and has been in the program since August 1974. Again, basic computations, fractions, decimals, percentage, vocabulary and reading were all given as important pre-entry skills.

The remaining interviews, regardless of "length of time in program" and "grades" proved to be a repeat of skills already noted. Students interviewed see a real need for a skills check instrument and were very supportive toward the project. This attitude is most likely due to the fact that academic skills necessary to pass coursework and solve shop problems are not taught in class. It is assumed that students entering Automotive Mechanics will have the necessary skills. Apparently, this is not the case.

There were no inconsistencies or additions to the skills list supplied by the instructors. The content analysis was also compatible with this list. Therefore, the skills list developed from instructor interviews is the final form of pre-entry skills for Automotive Mechanics.

MACHINE SHOP SKILLS LIST

The Machine Shop skills list was derived from a content analysis of course textbooks, interview with the instructor, and interviews with twelve students. Students were working on various projects at the time of interviewing and as a result several students were not present. Therefore "availability" was the determining factor as to who was interviewed. Although "length of time in the program" was not a deciding factor, a good spread was obtained. "Length of time in program" for interviewed students was.... since January, 1975 = three students; since September, 1974 = three students; since June, 1974 = two students; for more than one year = four students. Grades ranged from "C" to "A".

Content Analysis

A content analysis of Machine Shop textbooks suggests a need for basic computations, fractions, decimals and about twelfth grade reading ability. Since the entering student will be confronted with machine shop jargon in the classroom and shop, vocabulary may be a necessary pre-entry skill.

Instructor Interview

The interview began the same way others had. The instructor desired a screening device to turn away certain students. Repeated explanation of project's objectives was necessary. After an understanding was reached the instructor listed the following skills as desirable pre-entry skills. Basic computations as well as some knowledge of fractions and decimals are a must. The instructor does teach math beginning with fractions and ending with algebra. Normally, our purposes would suggest that since fractions and decimals are taught in class we should not use them as pre-entry skills. However, in this case it is believed necessary to have a check on them. (It was learned that math instructions moves rapidly and is not extensive. Besides the time factor, most students when interviewed, voluntarily expressed a low opinion of the instructor's ability to adequately teach math.)

Reading and vocabulary were cited as necessary prerequisites by the instructor. One of the problems facing the instructor is the time he wastes by telling or showing a student over and over again what something is or how to find it. He explained that if a student could read and comprehend and had a good vocabulary they could assist themselves and release him for other duties.

He also mentioned he would like a means by which an applicant's logic could be checked. Further probing revealed that by checking an applicant's logic, he meant a check on an applicant's ability to conceptualize, i.e., identify an object from three different viewpoints. This skill may be outside project's objectives. The skill is taught in the class under the label "Blueprint Reading".

In review, skills listed as important pre-entry skills by the instructor are:

Basic Calculations

1. Addition of whole numbers
2. Subtraction of whole numbers
3. Multiplication of whole numbers
4. Division of whole numbers

Fractions

5. Addition of fractions
6. Subtraction of fractions
7. Multiplication of fractions
8. Division of fractions
9. Fractions to decimals

Decimals

10. Addition of decimals
11. Subtraction of decimals
12. Multiplication of decimals
13. Division of decimals
14. Decimals to fractions
15. Comparing decimals
16. Rounding off

Reading

17. Comprehension

Vocabulary

18. Approximate meaning (synonym)

Conceptualization

19. Three viewpoints

Student Interviews

Student One... Student was rated "C" and has been in the program since September, 1974. Pre-entry skills mentioned as important were basic computations, fractions, decimals. He thought the skills check was a good idea and believed previous machine shop experience would be a good addition to the check.

Student Two... Student was ranked "C" and had been in the program since September, 1974. Reading, vocabulary, basic computations, fractions, and decimals, manual skills and a visual test on dimensions were listed as necessary pre-entry skills.

Student Three... Student was ranked "B" and had been in the program since June, 1974. He mentioned basic computations, fractions, decimals, algebra, geometry and a visual test on dimensions as necessary pre-requisites.

Student Four... Ranked "A" by instructor and has been in the program since September, 1974. She was experiencing no difficulty with coursework, in fact, she was tutoring some of the students. She did mention that she was finding it difficult to be accepted in a trade that had traditionally attracted only males. Skills listed as necessary pre-entry skills were basic computations, fractions, decimals, reading, vocabulary and a dimensions test.

After the fourth interview, interviews reached a plateau of similarity. No additions or inconsistencies between the first four interviews and the remaining eight were noted. The skills list was made up of the following skills: basic calculations, fractions, decimals and reading. Vocabulary was believed necessary by five students. Seven students did not list vocabulary as important. At first glance this may appear to show lack of support for having a vocabulary skill. It was thought that by noting a student's length of time in the program, an explanation may be offered. Students who listed vocabulary as important may have spent less time in the program and therefore had some difficulty with new words, whereas older students should have incorporated most shop orientated words into their vocabulary. This was not the case. The seven students who did not list vocabulary as important represented all points along the "length of time in program" dimension. So did the five who listed vocabulary as important. Perhaps this is an illustration of inconsistency, but there appears to be enough support to include vocabulary in the skills list.

A check to determine an applicant's ability to conceptualize was mentioned as important by six students. Combined with instructors expressed desire for a check on this ability supplies enough support for its inclusion in the final check list. However, it must be determined if conceptualization falls within the project's domain. A decision will have to be made before conceptualization is included in the skills list.

Noting no additions or significant inconsistencies the final skills check will be the same as the one developed from data obtained from the instructor's interview.

SKILLS LIST

The following skills lists are in final form for Office Occupations, Automotive Mechanics and Machine Shop:

Office Occupations

Identifying Parts of Speech

1. Nouns
2. Pronouns
3. Adjectives
4. Verbs
5. Adverbs
6. Prepositions
7. Conjunctions

Capitalization

8. First word of every sentence
9. Brand names
10. Building names
11. Business firms
12. Days, months
13. Historical events, periods, documents
14. Institutions
15. People
16. School terms
17. Title of publications
18. Places

Identifying Parts of Sentence

19. Subject
20. Object
21. Predicate

Punctuation

22. Quotation marks
23. Apostrophe
24. Period
25. Question mark
26. Exclamation point

Word Usage

27. Correct use of pronouns
28. Similar sounding words
29. Correct use of verbs

Spelling

30. Common words (20 words)

Vocabulary: Meaning of words

31. Approximate meaning (synonym) (25 words)

Reading

32. Comprehension

Automotive Mechanics

Basic computations

1. Addition of whole numbers
2. Addition of money: dollar sign and decimal point
3. Subtraction of whole numbers
4. Subtraction of money using dollar sign and decimal
5. Multiplication of whole numbers
6. Multiplication of money using dollar sign and decimal point
7. Division of whole numbers
8. Division of money using dollar sign and decimal point
9. Computing averages

Fractions

10. Addition of fractions
11. Subtraction of fractions
12. Multiplication of fractions
13. Division of fractions
14. Reducing fractions
15. Unlike fractions
16. Fractions to decimals
17. Fractions to percent

Decimals

18. Reading and writing decimals as numbers and words
19. Addition of decimals
20. Subtraction of decimals
21. Multiplication of decimals
22. Division of decimals
23. Comparing decimals
24. Rounding off
25. Decimal to percent

Percentage

26. Percent to decimal
27. Percent of a total

Reading

28. Comprehension (with grade level)

Vocabulary

29. Approximate meaning (synonym)

Machine Shop

Basic Calculations

1. Addition of whole numbers
2. Subtraction of whole numbers
3. Multiplication of whole numbers
4. Division of whole numbers

Fractions

5. Addition of fractions
6. Subtraction of fractions
7. Multiplication of fractions
8. Division of fractions
9. Fractions to decimals

Decimals

10. Addition of decimals
11. Subtraction of decimals
12. Multiplication of decimals
13. Division of decimals
14. Decimals to fractions
15. Comparing decimals
16. Rounding off

Reading

17. Comprehension

Vocabulary

18. Approximate meaning (synonym)

Conceptualization

19. Three viewpoints

CONSTRUCTION OF TEST ITEMS

Before item construction begins it is necessary to resolve certain issues. It was pointed out in the Statement of Problem section that standardized tests used for diagnosing skills or predicting success of vocational school applicants have fallen short in two areas. Many standardized tests contain items that are not relevant to the applicant's chosen program. Also, standardized tests often have items that are culturally biased or rely too much upon verbal skills. One must ask what is being tested... an applicant's socio-economic status, ability to read and communicate, or vocationally-related skills? It seems most inappropriate to make decisions about an applicant's competencies and probability of success in his/her chosen vocational area upon results influenced by items tapping skills that lie outside of that area. Thus, items for vocational tests should be designed to circumvent the problem of incorporating extraneous factors into test results.

Another problem that must be dealt with is the assumption of validity that one makes when developing an item. That is, the developer assumes that the item will measure what he intends it to measure. To assure valid test items, underlying assumptions must be put to task. For this purpose, as well as others, the contractual services of Dr. Charles Schultz were relied upon.[2] The value of his objective and competent eye cannot be over-estimated.

It is believed that the following procedure used for developing test items resolves the problems listed above. Initially, item construction begins with the knowledge and judgment of the assistant researcher. The content analysis and interviews used to develop the skills list serve as an excellent springboard for construction of test items. If the research assistant is thorough, he will be familiar with each program's social and physical settings, equipment and related problems. This information forms an excellent resource pool which can be drawn upon for item construction. Items can be designed to tap a skill while framed within the context of a particular vocational program. So, not only are the skills specific to a particular program, but the way they are presented is specific as well.

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[2] The professional opinions and judgments of Dr. Charles Schultz, Third-Party Evaluator, were utilized throughout all phases of item construction.

All vocabulary words used in a Skills Check met two criteria. They are common to the program that the Skills Check is designed for, and they are predicted to be at the ninth grade level of difficulty.

The Reading Comprehension section of a Skills Check is comprised of what is considered to be neutral reading material. That is, the material is such that there is not much chance that "previous knowledge" of the applicant will be a factor. Often material used to measure reading comprehension is technical in nature, i.e., a passage on how to operate a certain machine. This often results in giving those who have worked with such a machine, or are familiar with whatever the passage is about, an unfair advantage. It is quite possible that such a reading comprehension check will measure an applicant's previous experience rather than reading comprehension. Neutral material was considered to be historical in content. The Office Occupation's Reading Comprehension section was made up of three sections titled "History of the Typewriter," "History of Typewriting Instruction," and "History of Typewriting Textbooks." It is believed the chances of applicants being familiar with this material is minimal. Given pre-test and current testing results, this assumption appears to be reasonable. All reading comprehension sections were designed to meet the readability level required by the program..

All items designed to tap English and math skills were expressed in a way specific to a particular program. For instance, an addition problem appearing in a Machine Shop Skills Check could require the applicant to sum tolerances of a drive shaft. The same skill presented in an Office Occupations Skills Check could require the applicant to sum all the sales made in a day by a large business firm. In Auto Mechanics the same skill could be expressed by requiring the applicant to add up a service bill.

Another issue that must be dealt with is, how many items are sufficient to measure a skill? In math sections of the Skills Checks it was observed that some skills, such as selecting the largest decimal from a group of five, required only one operation (comparing decimals), and could be adequately measured by one or two items. A skill that requires more than one operation for completion, however, should be measured by three or four items. A story problem in addition requires the applicant to read through the problem, select pertinent figures, transfer them to provided working space and list them horizontally. This procedure could easily cause errors that result in an incorrect answer, independent of the addition skill being measured. Additional items tend to compensate for fortuitous errors and offer a more valid assessment of an applicant's skills. Therefore, the number of items believed necessary to adequately measure a skill were determined by the probability of fortuitous error factor. Pre-tests have given further credence and direction to this procedure.

The number of items measuring Spelling, Vocabulary, and Reading were determined by noting the number of items other such tests relied upon. In addition, spelling items were selected according to how well they covered the general rules of spelling.

Items measuring English skills, specifically Parts of Speech, Capitalization, Parts of a Sentence, Punctuation and Word Usage need to cover several usages of a skill. In Punctuation there are eight different situations that require the use of a comma, eleven different situations that require capitalization. Items must cover all situations applicable to a specific skill in order to adequately measure the applicant's proficiency with that skill. Therefore, the number of items designed to measure the above listed skills was determined by what was required to measure all uses of the skills.

REVIEW AND CRITIQUE OF TEST ITEMS

After the Research Assistant had completed development of criterion-referenced items for each skills list, a meeting was scheduled between the Principal Investigator, Research Assistant and Third-Pary Evaluator. At this meeting, all items were evaluated by the Third-Party Evaluator and maintained or revised according to how well they met conditions of: 1) Clarity of directions. Each item must be explicitly clear regarding what it requires the applicant to do. 2) Validity of test items. There must be an exact fit between the item and skill. Anything less could result in the item measuring something other than what was intended. 3) Level of difficulty. Items must be at the determined level of difficulty. Most items for the three Skills Checks are at the ninth grade level of difficulty. 4) Number of items necessary to measure a skill (already discussed). 5) Relationship between item and skill. Items were reviewed as to how well they met requirement of being specifically designed for a particular program.

PRE-TESTS

Upon completion of item revision, pre-test arrangements were made. The pre-tests served the dual function of identifying those students with specific weaknesses and providing information needed to determine what items were suitable to project needs and what items needed revision (discussed in Item Analysis section).

The Skills Checks were administered to 90 students in Office Occupations, 71 students in Automotive Mechanics and 50 students in Machine Shop.

MEASURES OF VALIDITY

A validity check is essentially a procedure designed to measure the effectiveness of a testing or measurement instrument. It is a comparison between what authors say their instrument will do (theory) and what the instrument actually does do (reality). If there is a close fit between theory and reality then the instrument, for all intents and purposes, is valid. That is, the instrument does what it was designed to do. If there is not a tight fit, then the instrument is measuring something other than what it was designed to measure and revision is necessary.

Office Occupations

In order to determine if the Office Occupations Skills Check was discriminating between proficient and deficient students, a comparison was made between students "new" to Office Occupations and successful students "old" to Office Occupations. "New" students were defined as those students who were beginning coursework or had not completed one full semester at date of test. "Old" students were defined as those students who had completed one or more semesters of coursework with at least a "C" average at date of test.

Since many of the pre-entry skills that appear on the Office Occupations Skills Check are reviewed in class, it was assumed that "successful old" students, having gone through at least one semester of coursework, should score higher than "new" students. As a group, the "successful old" student mean ($\bar{X}$) should be higher than the "new" student mean. No difference between means could indicate one or more of the following circumstances: 1) The items are not discriminating at an appropriate level; 2) Level of difficulty needs revision; 3) The unlikely possibility that "new" students are as proficient with pre-entry skills as are "successful old" students;

4) The skill is not a suitable candidate for testing in Office Occupations; 5) Instruction needs revision.

Graphs 1 thro IX all reveal mean differences in the expected direction. Differences in mean scores for skills in Math, Parts of Speech, Punctuation and Spelling appear to be significantly different.

An external validity measure was implemented to determine the predictive ability of the Office Occupations Skills Check. At the end of the semester, the English scores for each "new" student were compared with the English instructor's evaluation.[3] Evaluation was accomplished by "Q-Sort" method. The instructor was handed cards with a "new" student's name on each card. The instructor was then requested to arrange the cards according to student proficiency. The students were ranked from most proficient to least proficient student. Attendance and motivation were not considered. The instructor directed herself to only questions of, can the student do the work and how well can he/she do it? If the instrument has good predictive ability then one should observe a high correlation between Skills Check English scores and teacher's evaluation. Those "new" students who scored higher on the English part of the Skills Check should also be evaluated higher by the English instructor.

Graph X indicates that the Office Occupations Skills Check has reasonably good predictive ability regarding English skills.

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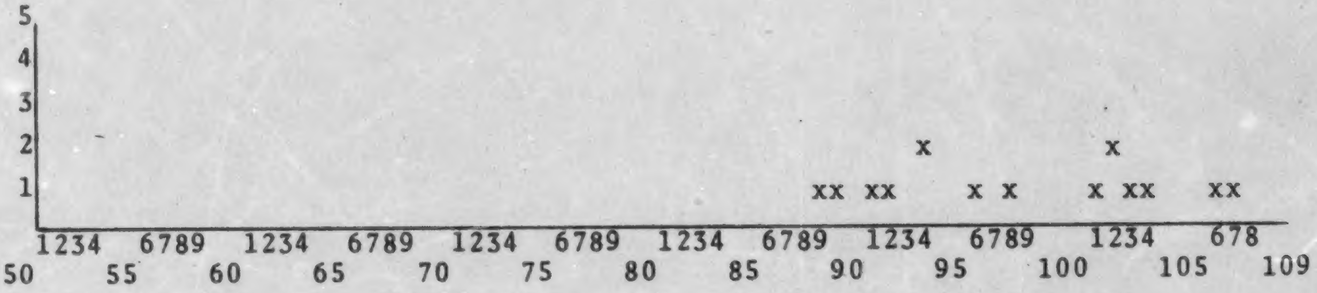
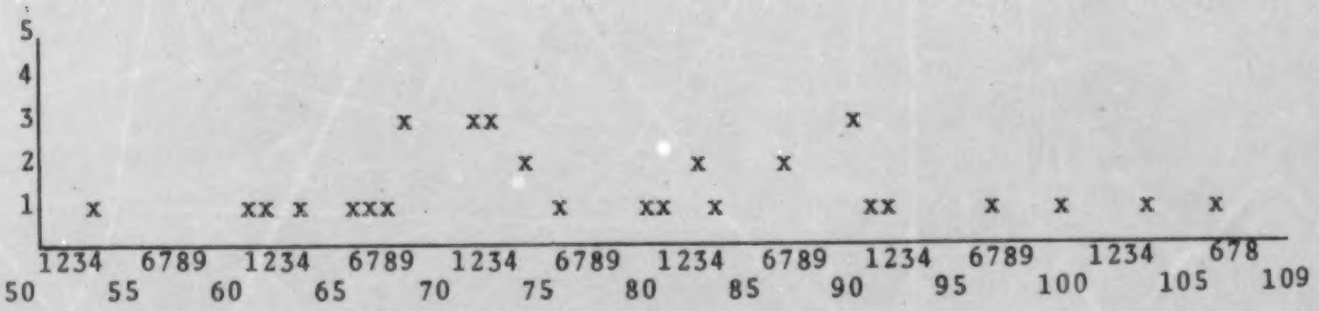
3. At this point in time, "new" students had not taken the Office Occupation's math course. Therefore, an external validity check on math skills was not possible. However, since the project has been refunded, this information will be in the June, 1976 report.

GRAPH I
Office Occupations: Math

Old Students
N = 15, $\bar{X}$ = 97.73



New Students
N = 36, $\bar{X}$ = 78.33

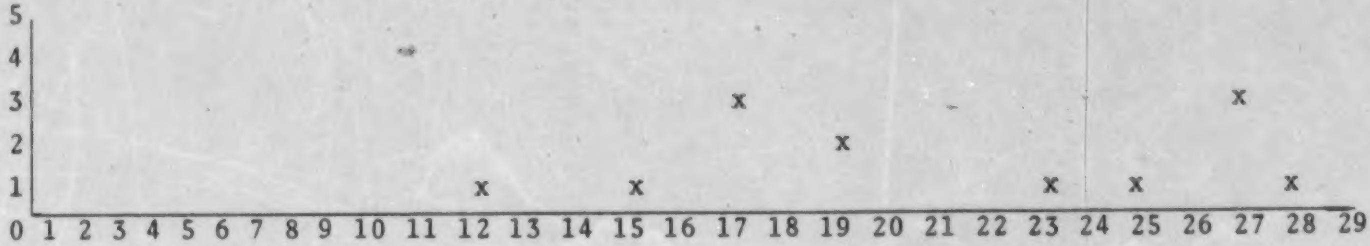


GRAPH II

Office Occupations: Parts of Speech

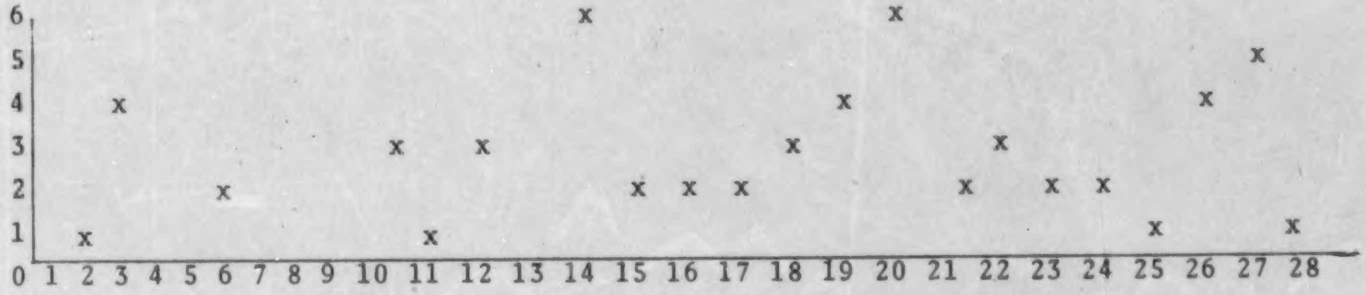
Old Students

N = 13, $\bar{X}$ = 21.15



New Students

N = 59*, $\bar{X}$ = 17.41



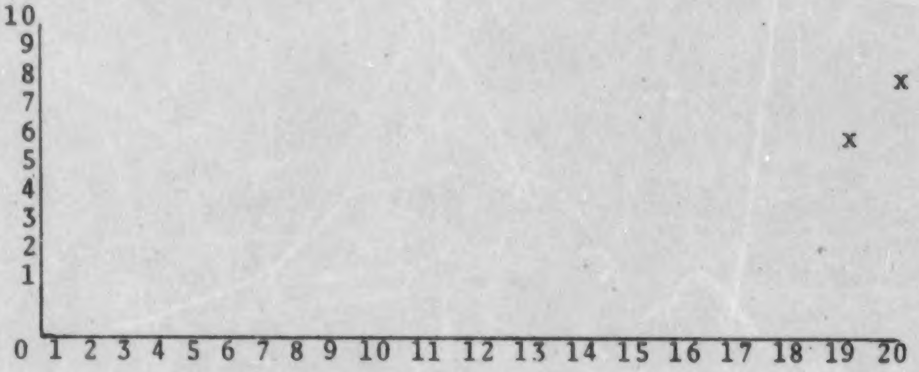
* Number of students will differ from section to section due to incomplete or unusable sections.

GRAPH III

Office Occupations: Capitalization

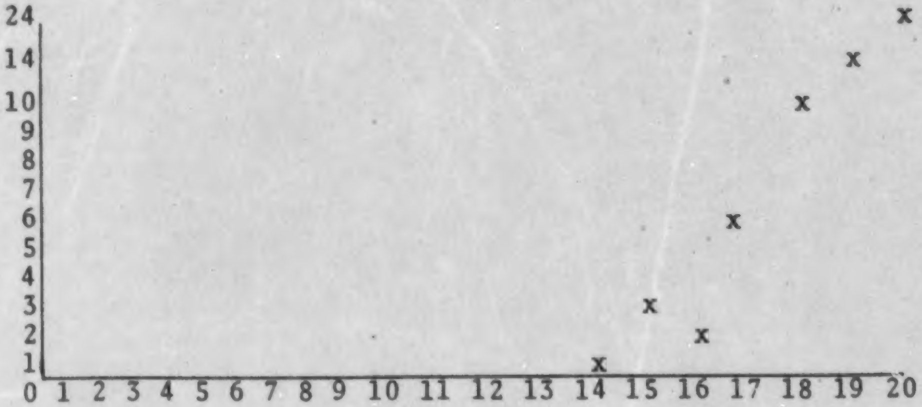
Old Students

N = 13, $\bar{X}$ = 19.62



New Students

N = 61, $\bar{X}$ = 18.34

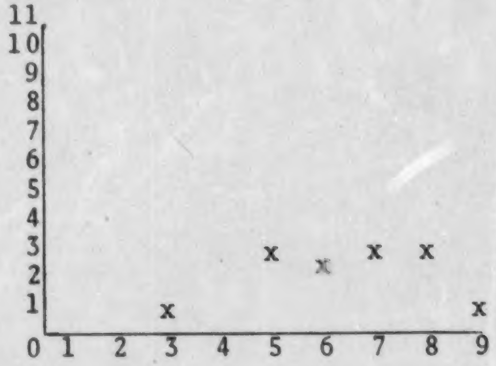


GRAPH IV.

Office Occupations; Parts of a Sentence

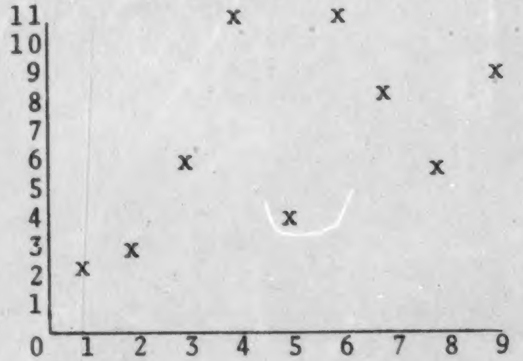
Old Students

N = 13, X̄ = 6.46



New Students

N = 59, X̄ = 5.55

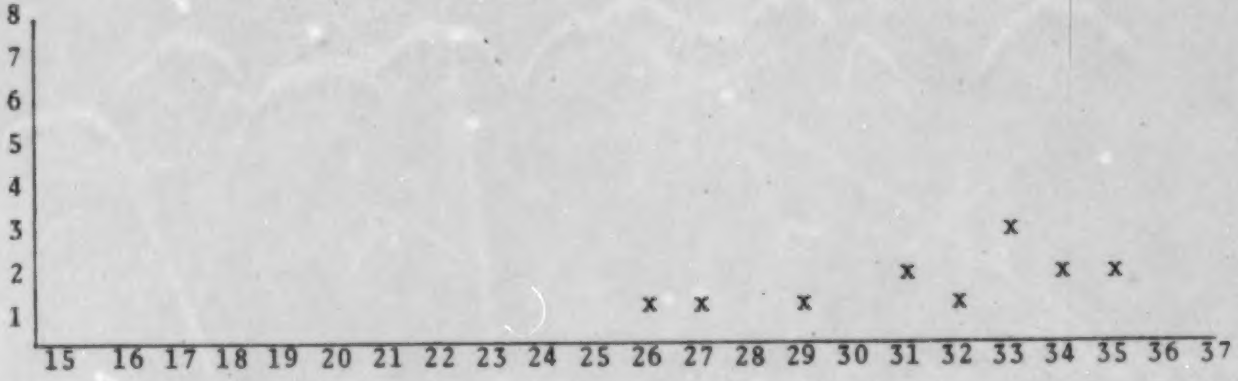


GRAPH V

Office Occupations: Punctuation

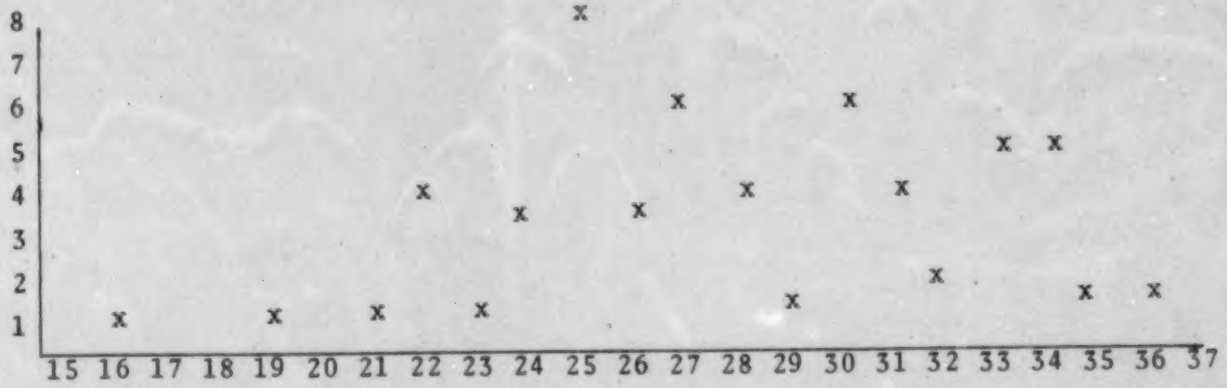
Old Students

N = 57, $\bar{X}$ = 27.96



New Students

N = 13, $\bar{X}$ = 31.77

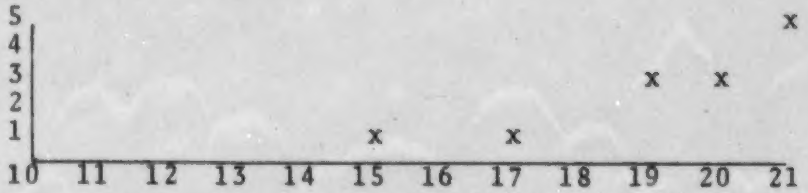


GRAPH VI

Office Occupations: Word Usage

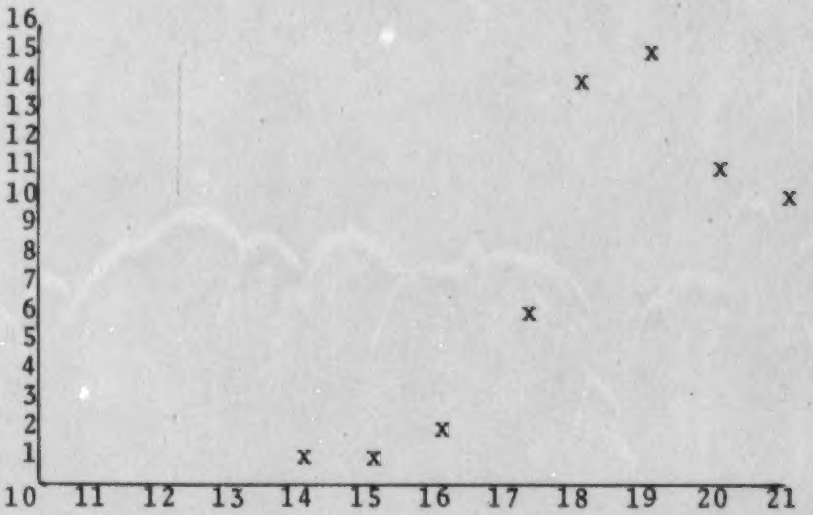
Old Students

N = 13, $\bar{X}$ = 19.54



New Students

N - 60, $\bar{X}$ = 18.83

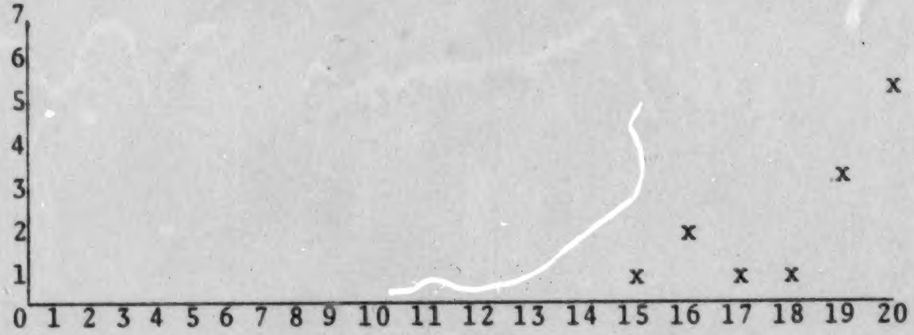


GRAPH VII

Office Occupations: Spelling

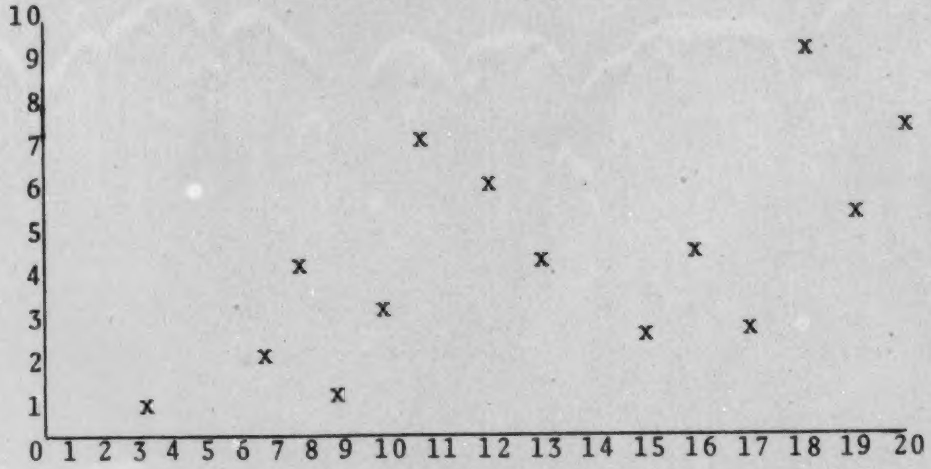
Old Students

N = 13, $\bar{X}$ = 18.38



New Students

N = 60, $\bar{X}$ = 14.27

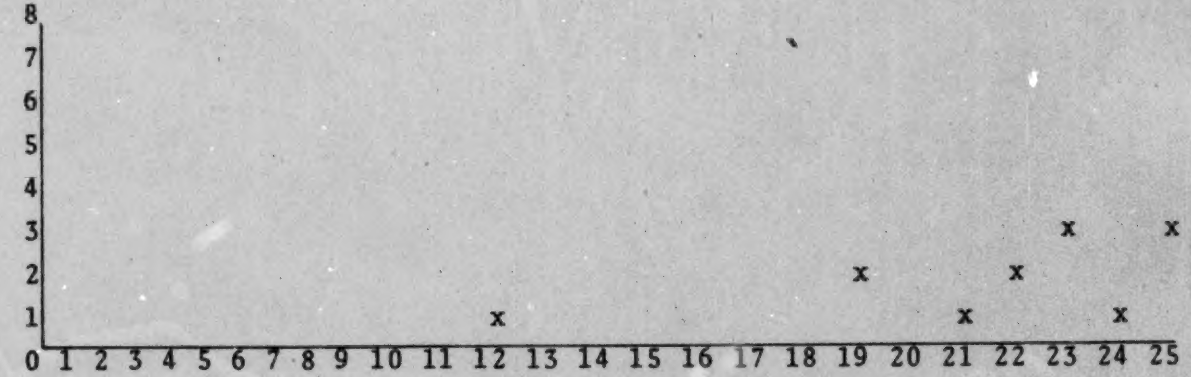


GRAPH VIII

Office Occupations: Vocabulary

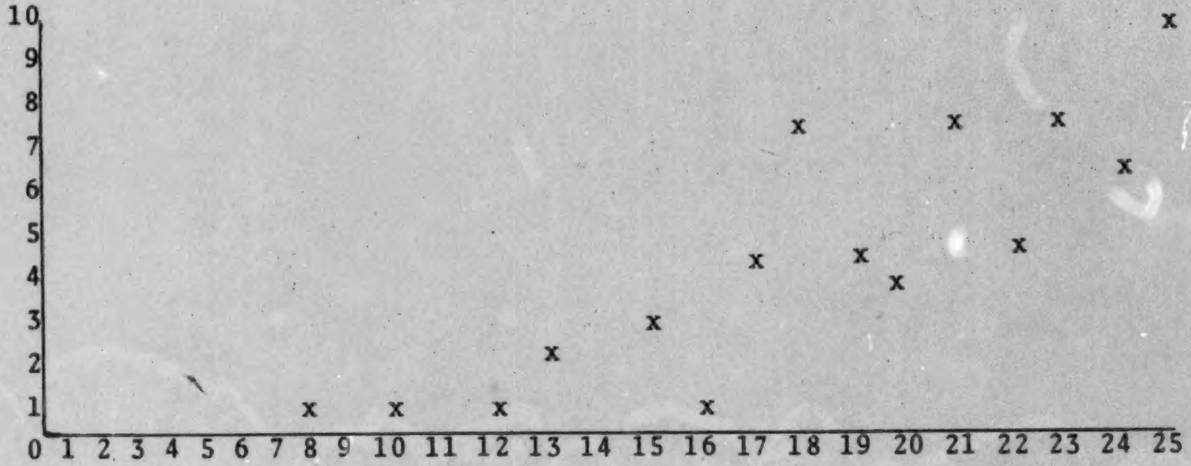
Old Students

N = 13, $\bar{X}$ = 21.77



New Students

N = 60, $\bar{X}$ = 20.20

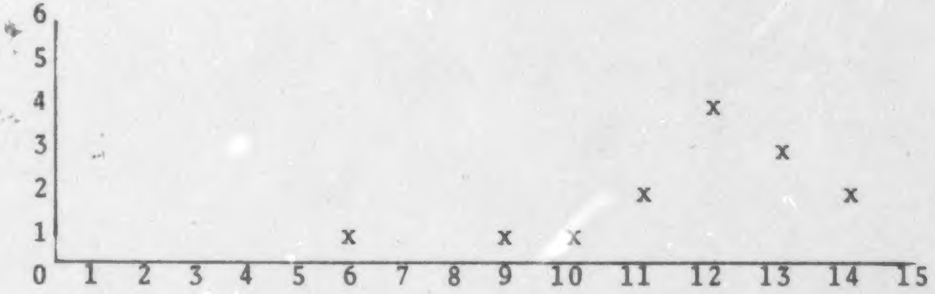


GRAPH IX

Office Occupations: Reading

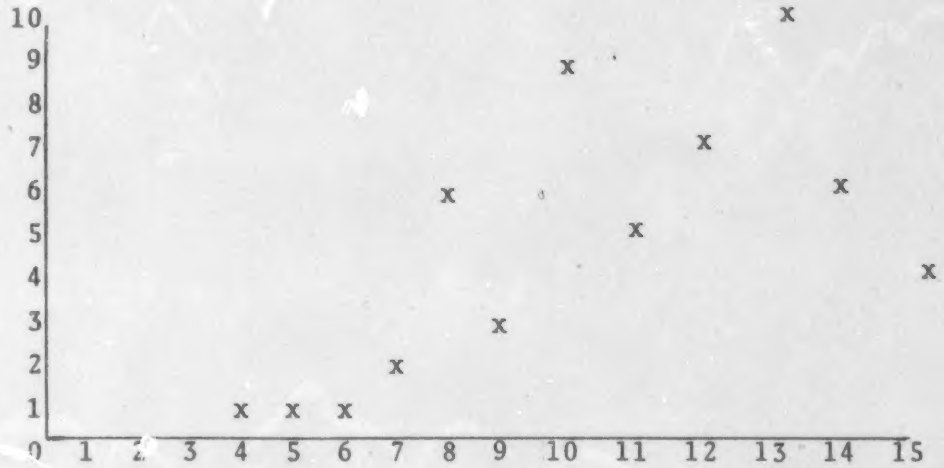
Old Students

N = 13, $\bar{X}$ = 12.00



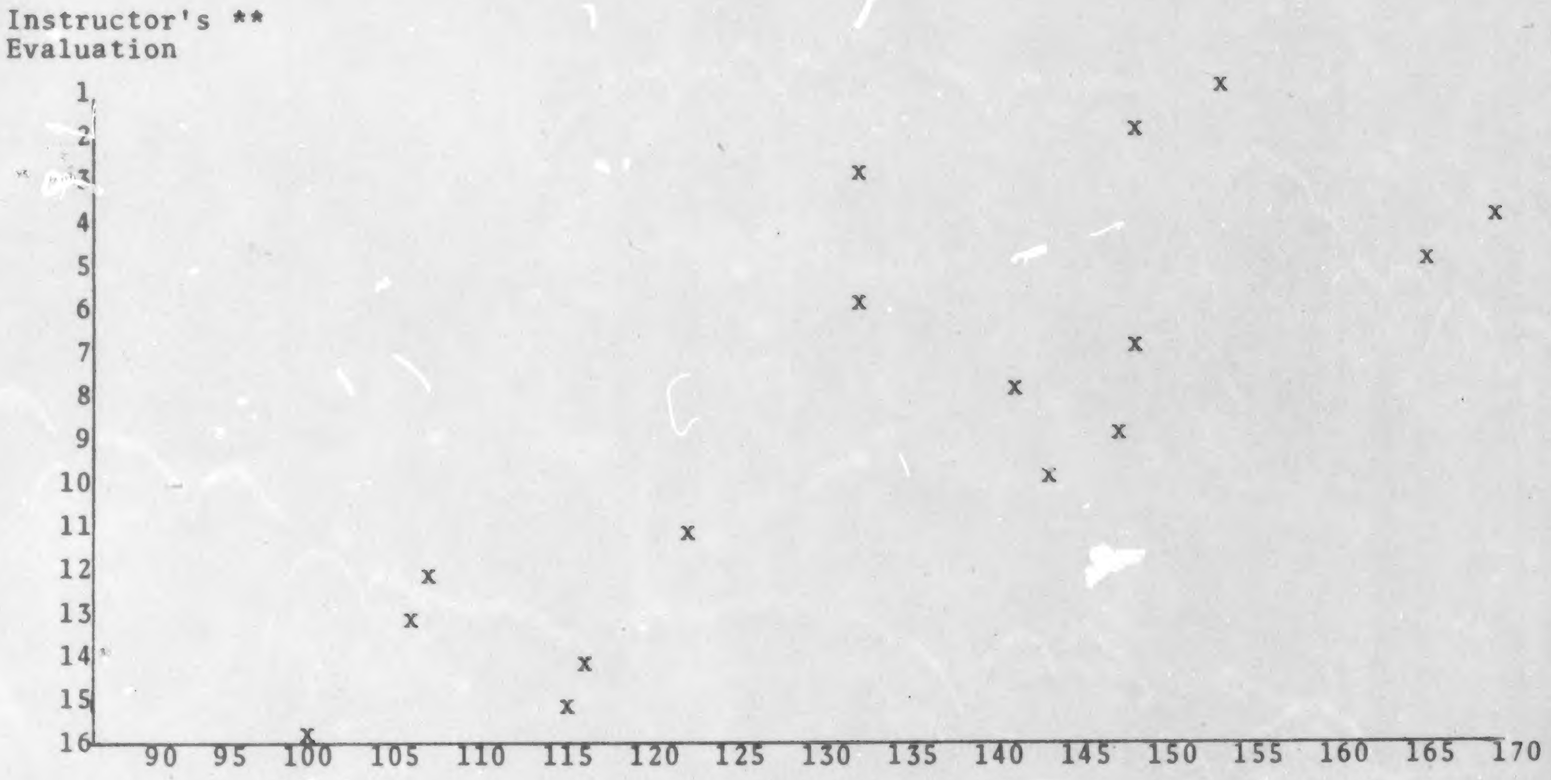
New Students

N = 55, $\bar{X}$ = 11.04



GRAPH X

Office Occupations: English External Validity Check*



* All English sections were combined to form a total English Score. New students evaluated in the English External Validity Check had completed one semester of Office Occupations English.

** Number 1 represents the most proficient student and Number 16 represents the least proficient student. All other students were ranked somewhere in between.

Automotive Mechanics

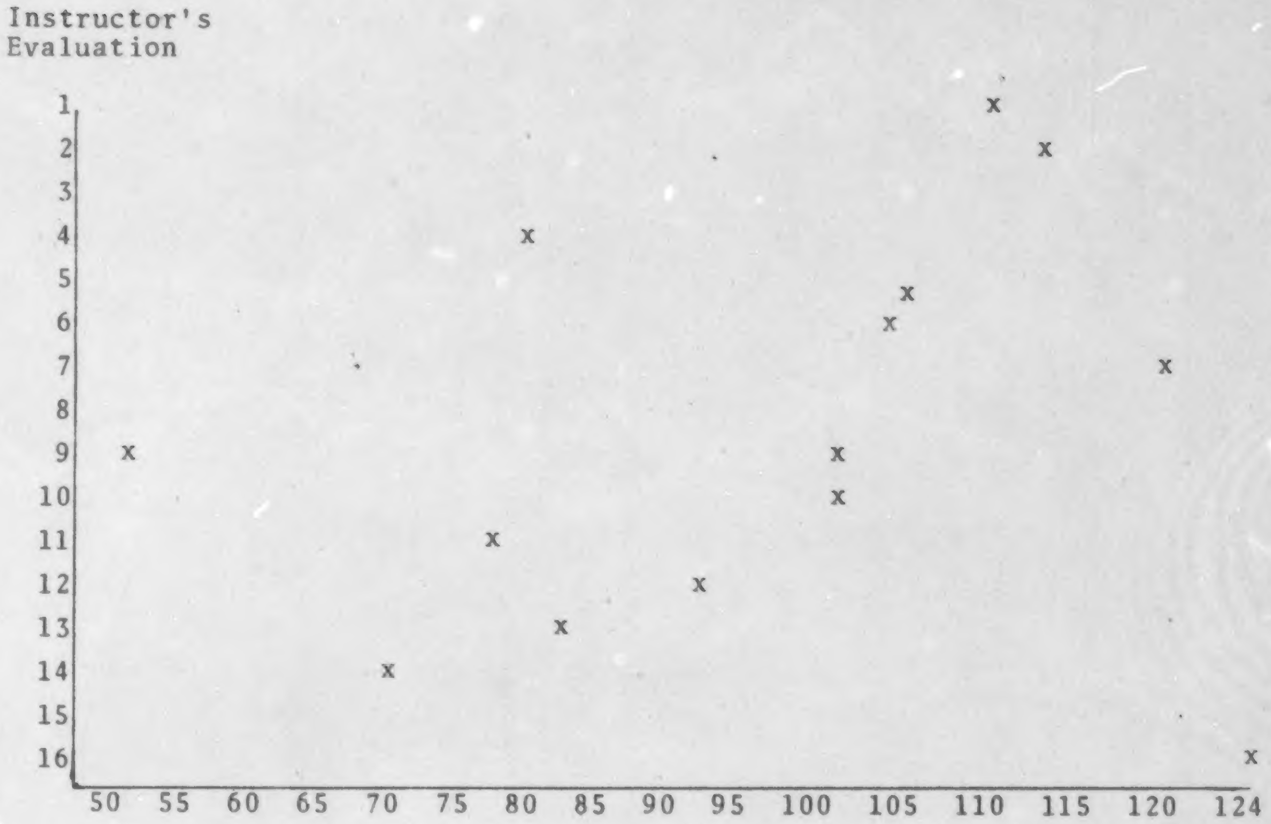
Unlike instructors in Office Occupations, Automotive Mechanics' instructors teach numerical-verbal skills as required by the trade. Since instructors do not emphasize these skills, students are graded on other factors such as motivation, attendance, and work assignments in the shop and classroom. As a result it was not possible to compare "new" students with "successful old" students. Students defined by the instructor's evaluation as "succesful old" students were successful in ways other than numerical-verbal proficiency. This is illustrated by the finding that ten out of twenty-three "successful old" students, rated high (B grade or better) by instructors, received scores in the math section of the Skills Check that were noticeably lower than the group mean. Further, a Q-Sort technique revealed that although Skills Check scores for "new students" appear to be in the right direction, there are several negative cases. (See Graphs XI, XII, and XIII)

In light of this, the question arises, if numerical-verbal abilities are not important for success, why teach them? In reponse to this question, the content analysis, student and instructor interviews supported the need for an entering student to have numerical-verbal skills. This suggests that perhaps instructional materials should include numerical-verbal skills and that evaluation of students should be expanded.

At this point in time the Automotive Mechanics Skills Check appears to be meeting project needs, i.e., identifying those students who exhibit deficiences. Graphs XIV, XV, and XVI illustrate recorded scores of "new" students. It can be observed that some students scored noticeably lower than others. These students were located for remediation.

GRAPH XI

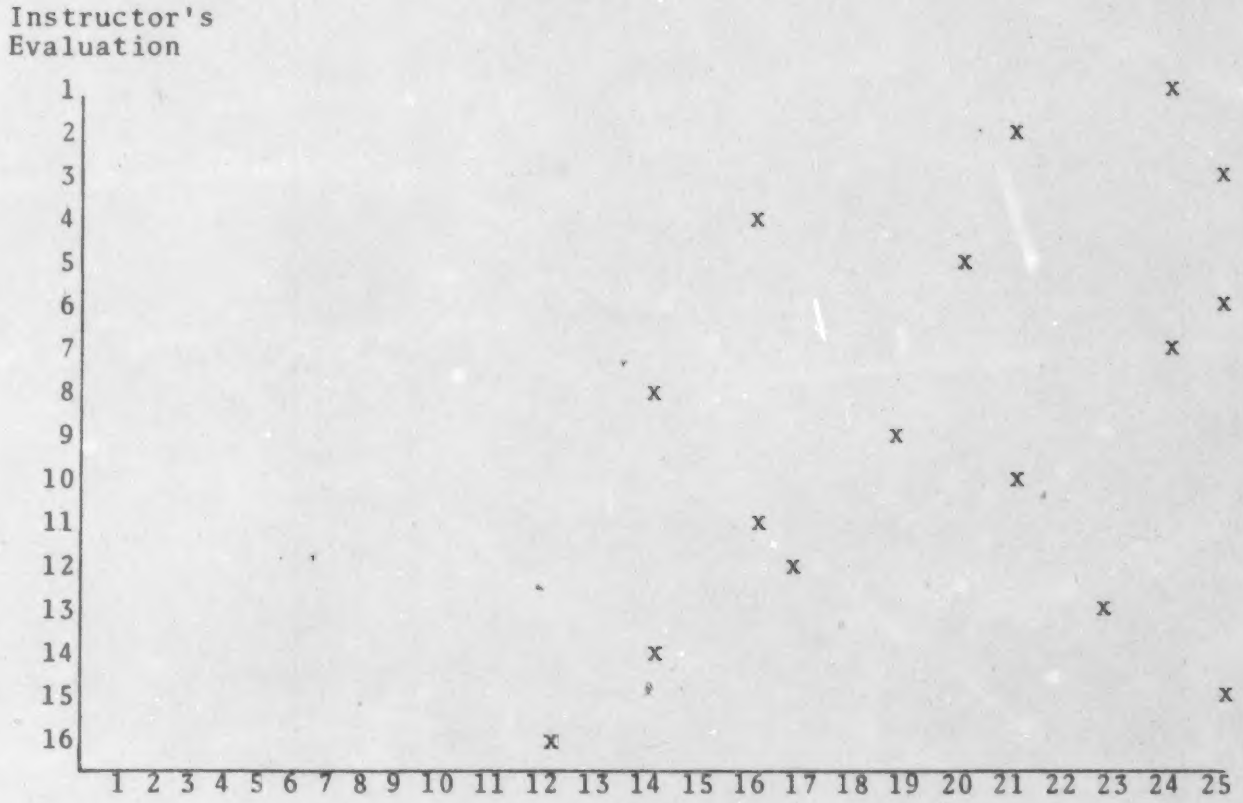
Automotive Mechanics: Math External Validity Check*



* New students evaluated in all Automotive Mechanics External Validity Checks had completed one semester of Automotive Mechanics.

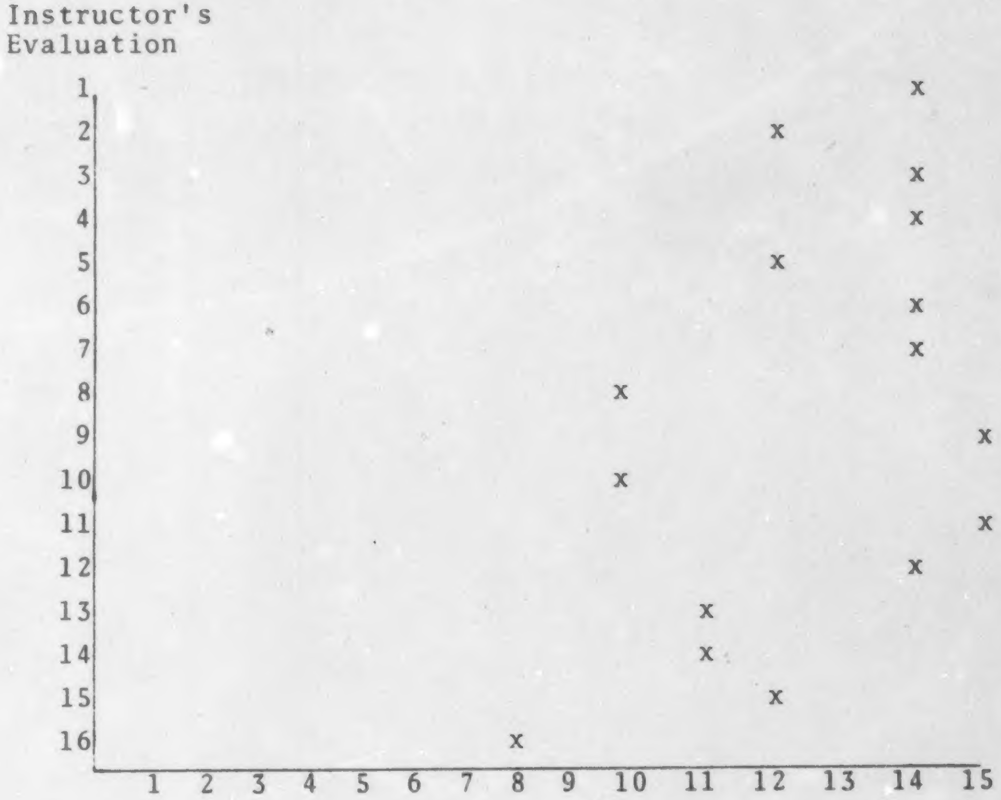
GRAPH XII

Automotive Mechanics: Vocabulary External Validity Check



GRAPH XIII

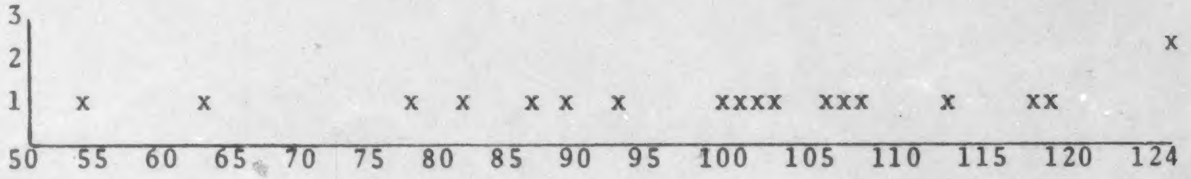
Automotive Mechanics: Reading External Validity Check



GRAPH XIV

Automotive Mechanics: Math

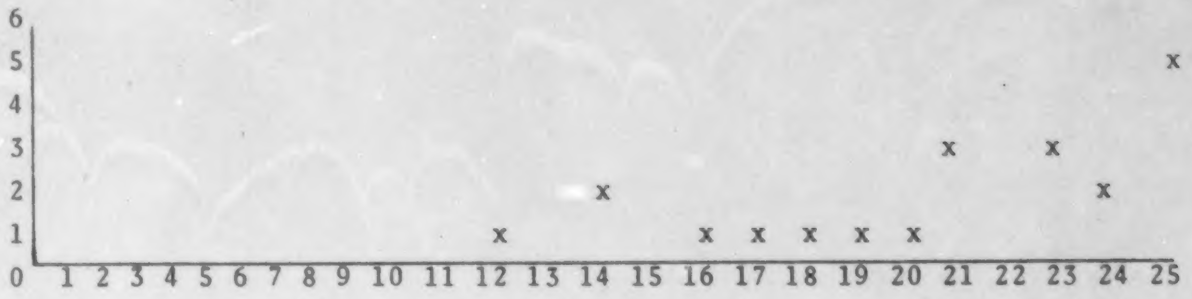
New Students
N = 19, $\bar{X}$ = 98.68



GRAPH XV

Automotive Mechanics: Vocabulary

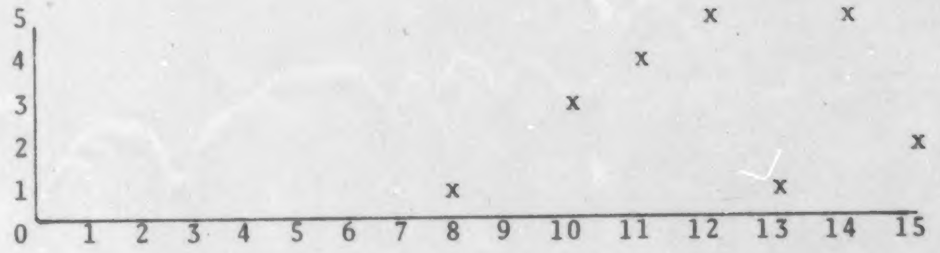
New Students
N = 21, $\bar{X}$ = 20.71



GRAPH XVI

Automotive Mechanics: Reading

New Students
N = 21, $\bar{X}$ = 12.14



Machine Shop

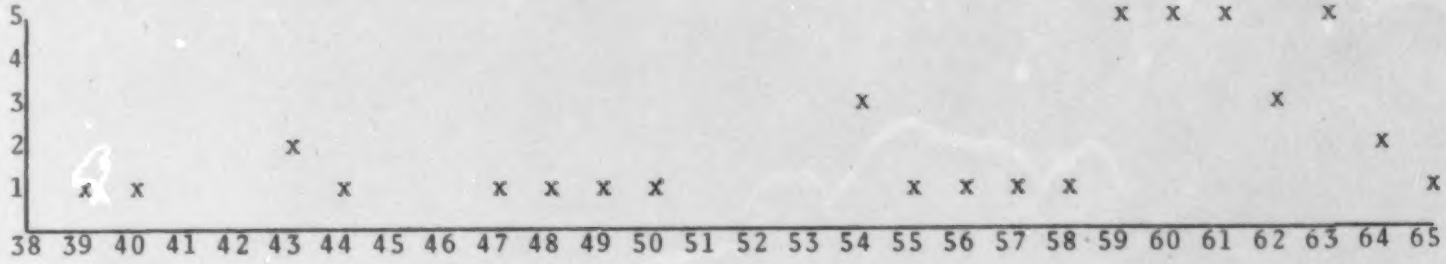
At the time of testing there were no "new" students in the Machine Shop Program. Forty-three "old" students were tested and their test results were graphed. These graphs will serve as referees regarding issues of discrimination between proficient and deficient students. Like Office Occupations, many of the pre-entry skills that appear on the Machine Shop Skills Check are reviewed in class. Therefore, a comparison of means between "old" students who have undergone machine shop training and "new" students who have not undergone machine shop training, should reveal that "old" students, as a group, score noticeably higher than "new" students.

After Fall semester, a Q-Sort will be administered to the instructor. The instructor will be requested to evaluate "new" students after one semester of training. Evaluations will be compared with Skills Check scores obtained by entering students at the beginning of Fall semester. If the Skills Check has predictive value there should be a high correlation between instructor's evaluation and student's score.

Graphs illustrate the numerical-verbal placement of "old" students and the means ($\bar{X}$) that will be used in comparison with "new" students' scores.

GRAPH XVII
Machine Shop: Math

Old Students
N = 42, X̄ = 57.34

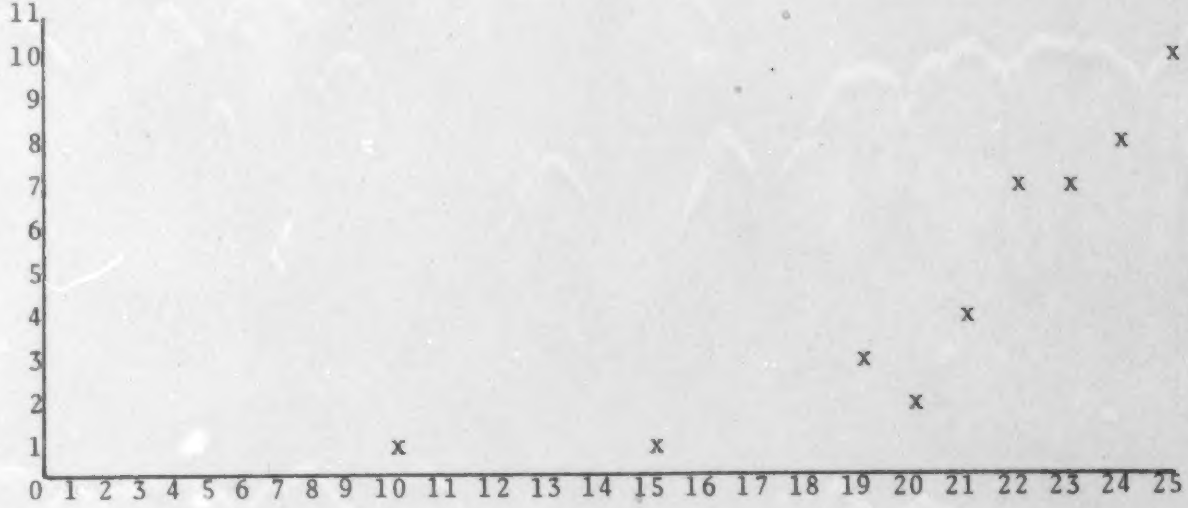


GRAPH XVIII

Machine Shop; Vocabulary

Old Students

N = 43, $\bar{X}$ = 23.30

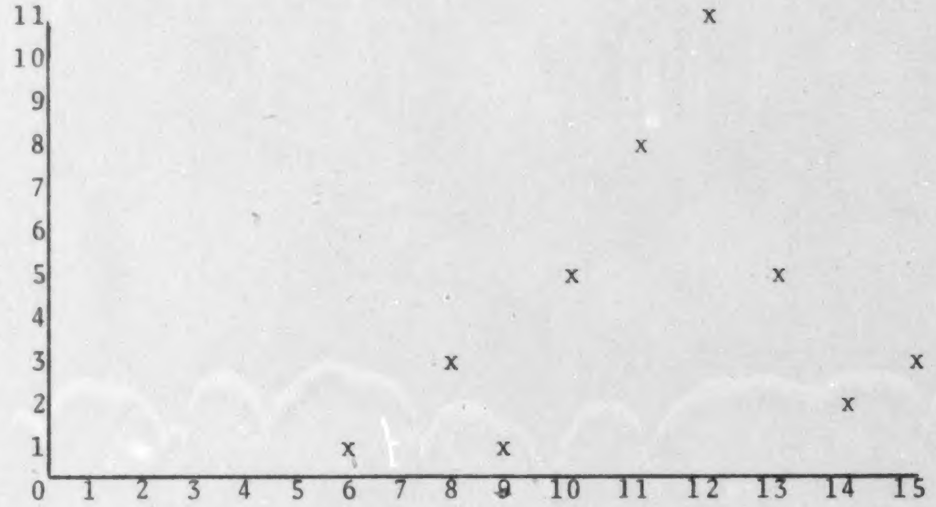


GRAPH XIX

Machine Shop: Reading

Old Students

N = 39, $\bar{X}$ = 11.21



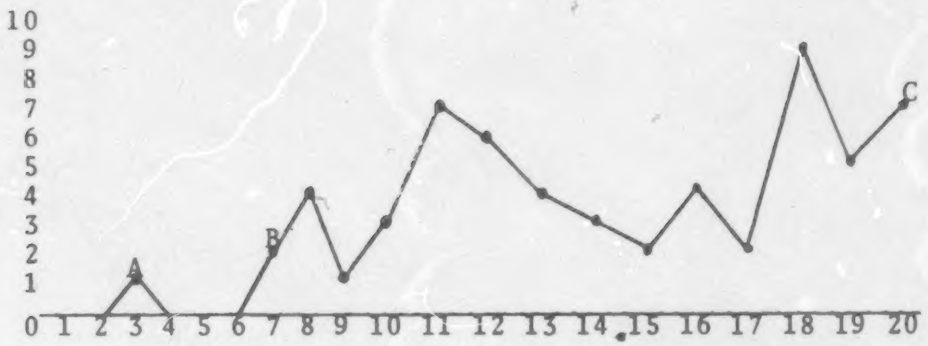
ITEM ANALYSIS

Besides dealing with issues of validity, information gained through pre-testing was used for performing item analysis. All items used in pre-tests underwent item analysis. Item analysis is a non-complicated statistical technique specifically designed to assess the discriminatory power of a test item. By discriminatory power it is meant the ability of an item to discriminate between students with proficient skills and students with deficient skills. Ideally, every item in final form would have discriminatory power that would allow proficient students to be the ones most likely to get the item correct and deficient students to be the ones most likely to miss the item. Since the purpose of this project is to make visible students who need remedial education, given vocational interests, item analysis speaks directly to project needs.

Item Analysis Procedure:

After the exam has been administered and corrected, each section composed of X number of items is divided into groups of Hi or Lo. It is necessary for each group to have the same amount of students. The best way to proceed is to place all scores for a particular section in a range going from lowest to highest score. Drop the low and high extremes before you divide into Hi, Lo groups. This will create a population that approximates a normal distribution. (Normal distributions are more amenable and reliable for statistical procedures such as item analysis. See "Statistical Reasoning in Sociology," Mueller, Schuessler, Costner, for discussion to this point). To insure reliable results each group should have an N of at least 20. Figure I illustrates this initial step.

FIGURE I



1) Drop extremes A, B, and C

2) Divide remaining scores into two equal groups.
With this population Hi = 14 - 19, Lo = 8 - 13
There are 24 in each group.

Number all of the items that appear in the section. If an item has two or more answers number each answer separately, i.e., if item one had three answers it would be numbered 1a), 1b), and 1c). Review each exam noting whether the individual is in the Hi or Lo group. For each correct answer, place a tally mark behind the item's corresponding number in either the Hi or Lo column. Incorrect answers are not tallied so the completed tally sheet will be a count of correct answers only for both Hi and Lo groups.

Figure II shows the completed tally sheet for Office Occupations, Spelling:

FIGURE II

	HI	LO
personnel	~~1111~~ ~~1111~~ ~~1111~~ 1	~~1111~~ 111
Corporation	~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~	~~1111~~ ~~1111~~ 1
intention	~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ 111	~~1111~~ ~~1111~~ ~~1111~~
vocational	~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ 111	~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ 1
review	~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ 1	~~1111~~ ~~1111~~
statement	~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ 11	~~1111~~ ~~1111~~ ~~1111~~
employer	~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~	~~1111~~ ~~1111~~ ~~1111~~
Business	~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ 111	~~1111~~ ~~1111~~ ~~1111~~ 1
recommendation	~~1111~~ ~~1111~~ ~~1111~~	~~1111~~ 11
flexible	~~1111~~ ~~1111~~ ~~1111~~ 111	11
forty	~~1111~~ ~~1111~~ ~~1111~~ 111	~~1111~~ ~~1111~~ 1
twelve	~~1111~~ ~~1111~~ ~~1111~~ 11	~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ 1
occupation	~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~	~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ 1
similar	~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ 11	~~1111~~ ~~1111~~ 11
description	~~1111~~ ~~1111~~ ~~1111~~ 1	~~1111~~
developing	~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~	~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ 111
procedures	~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~	~~1111~~ ~~1111~~ ~~1111~~ 1
comparison	~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~	~~1111~~ ~~1111~~ ~~1111~~ 1
eligible	~~1111~~ ~~1111~~ ~~1111~~	11
truly	~~1111~~ ~~1111~~ ~~1111~~ 111	~~1111~~ ~~1111~~ 1

Go through each item noting how many of the Hi group and Lo group got the correct answer. If the item is discriminating there should be a noticeable difference between the Hi/Lo populations. With an N of 20, if the Hi group scores 5 more correct answers than the Lo group, the item is probably satisfactory. Anything less than 5 suggests the item needs to be made more difficult. If a negative relationship is noted, i.e, more of the Lo group got the item correct than the Hi group, the item should either be dropped or completely changed. If almost all examinees in both groups missed the item then the item may be a good candidate for omission because of the difficulty factor. Figure III, a totaled tally sheet, illustrates an array of discriminatory and non-discriminatory items.

FIGURE III

Item Analysis for Spelling, Office Occupations; New Entering Students

Hi = 14 - 19 25 in each group
Lo = 8 - 13

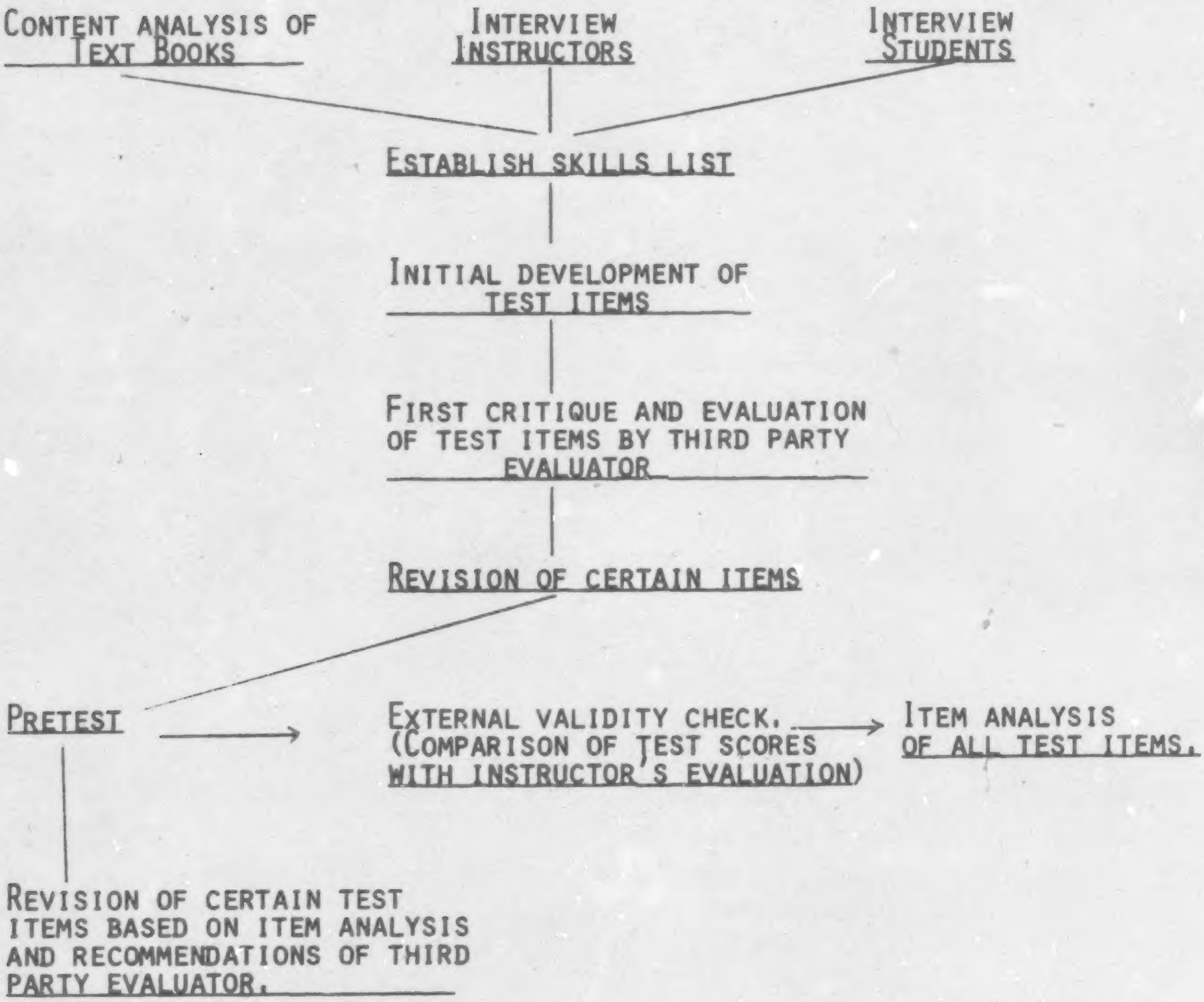
	Hi	Lo		Hi	Lo
personnel	16	8	forty	18	11
Corporation	24	11	twelve	24	21
intention	23	15	occupation	23	21
vocational	23	21	similar	22	12
review	21	10	description	16	5
statement	22	14	developing	24	23
employer	24	14	procedures	24	16
Business	23	21	comparison	24	16
recommendation	15	8	eligible	15	2
flexible	18	2	truly	18	11

Items 1, 2, 3, 5, 6, 7, 9, 10, 11, 14, 15, 17, 18, 19 and 20 are all good discriminators, especially items 2, 5, 7, 10, 14, 15 and 19. Items 4, 8, 13 and 11 are poor discriminators and should be changed. There are no negative items. Item analysis reveals that this section needs some revision, but overall is doing an excellent job differentiating proficient spellers from deficient ones.

Item analysis should never be the final word in item development. It is only a mathematical indicator of how well items are working, given your particular objectives. If items are developed to tap basic skills such as addition of whole numbers and item analysis of pre-test results reveal that there is a positive difference of only one between Hi/Lo groups, a change is not always necessary.

Given the skill involved, a difference of one may be good. Since the item represents a basic skill it is expected that most examinees will answer the item correctly. If they do not, perhaps the item should be considered a basic skill...perhaps the skills listed as important pre-entry skills are too difficult. There are many issues that item analysis does not deal with. The test developer must rely upon his own judgment as to whether an item is working. Item analysis should be considered a judgment aid. Any other use of item analysis could result in fitting the data to the statistical model rather than fitting the statistical model to the data.

DEVELOPMENTAL FLOW CHART
OF
PRE-ENTRY CRITERION-REFERENCED TESTS


CONTENT ANALYSIS OF TEXT BOOKS
INTERVIEW INSTRUCTORS
INTERVIEW STUDENTS
ESTABLISH SKILLS LIST
INITIAL DEVELOPMENT OF TEST ITEMS
FIRST CRITIQUE AND EVALUATION OF TEST ITEMS BY THIRD PARTY EVALUATOR
REVISION OF CERTAIN ITEMS
PRETEST
EXTERNAL VALIDITY CHECK. (COMPARISON OF TEST SCORES WITH INSTRUCTOR'S EVALUATION)
ITEM ANALYSIS OF ALL TEST ITEMS.
REVISION OF CERTAIN TEST ITEMS BASED ON ITEM ANALYSIS AND RECOMMENDATIONS OF THIRD PARTY EVALUATOR.

CONCLUSIONS AND CONTINUATION

During the initial grant years, FY 75, Renton Vocational Technical Institute developed three instruments for prescribing compensatory education. During the continuation grant year, Renton Vocational Technical Institute intends to develop an additional six test instruments. Areas anticipated for test development will be electronics, cashier checking, civil engineering, technology, major appliance repair, welding, and food preparation-food service. It is anticipated that this test development format will continue that developed during the initial grant year.

Other institutions have indicated interest in the Skills Check development project. Therefore, it is anticipated that in the forthcoming year, project staff will work cooperatively with other institutions in the development of Skills Checks. The test technician, based at Renton Vocational Technical Institute, will work in close cooperation with designated individuals from other institutes.

It is anticipated that the cooperation with the other institutions will give this project more generalized applicability throughout the state of Washington.

Following development of the test instruments, all will be field tested, both at the institutions in which they are generated and in other locations. Following the field tests, careful item analysis and evaluation of external as well as internal sources of documentation will be utilized.

Documentation generated through the field test phase of the project will be utilized in revision of all tests. The external evaluator, Dr. Charles Schultz, will give close supervision to field tests, test validation, item analysis, and revision of all tests.

A final set of test instruments will be prepared for printing. These final tests will be prepared in a format for reproduction by other institutions.

A new objective for the continuation project of FY 76 is the development of a teacher's manual to accompany the specific tests. This manual will contain an introduction to all tests developed, answers for all developed tests, information on proper utilization of test scores for the prescription of required compensatory education, and an overview of the method of item analysis developed for the purposes of the project.

Statewide dissemination of research projects always presents a problem for vocational educators. It is anticipated that in the spring of 1976, this project will be at such a level of development that it will be appropriate to present the project to state workshops, and to individual schools as requested. The project researcher will be available for such project dissemination. He will be equipped to go to specific locations throughout the state to present information on this specific project.

A final report will be generated in June of 1976. This report will contain all tests, all information contained in the teacher's manual, and additional information germane to the development of the project. In addition, it will contain the final report of the project evaluator. Project evaluation will be based upon the following:

A. Number of tests developed.
B. Number of students evaluated through tests.
C. Number of students receiving remedial education as a result of the tests.

D. Number of students successfully enrolled in vocational training programs as a result of the tests.

E. Subjective case studies generated by instructors in those areas in which tests are being developed.

F. Report generated by the external evaluator.

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COMPENSATORY EDUCATION FOR VOCATION TECHNICAL TRAINEES

--A Third Party Evaluation--

Students are sometimes unsuccessful in their classes when they lack certain skills that are basic to their coursework. Students sometimes wait for months to get into a technical program and then fail in the program because of poor educational preparation. The staff at Renton Vocational Technical Institute (RVTI) wants to prevent these failures.

This project aims to develop a way to identify the need for preparation in the basic skills. When a skills deficit is identified, it can be eliminated before the student begins the program.

Craig Mueller was selected as the Research Assistant for the project and has carried the largest share of the work. Three courses of study were selected to represent a cross section of training offered at RVTI. These are Office Occupations, Automotive Mechanics and Machine Shop.

The first step is to find out what skills are needed. This is addressed through a content analysis of course materials and interviews with instructors and students. The instructors tended to define the elementary levels of their subject matter as "prerequisites". It appears they would screen out the less proficient students and teach those who were more advanced. However, the school's policy is to accept all students and teach them what they need.

While the areas of prerequisite skills have been pretty well defined, the level of proficiency needed is still open to discussion. However, it is possible to develop tests that are sensitive across a range of proficiency levels.

The next step was to develop tests for the basic skills identified. Mueller carried out the test development. Test content was derived largely from textbooks used for the courses and for more basic coverage of the prerequisite skills. Course instructors were called upon for advice and review.

Content of test items was identified so that specific skills could be isolated. For example a test item measuring punctuation were differentiated so that a skill such as "using a comma to set off an appositive" could be isolated. More precise definitions of specific skills were possible for writing and mathematics than for vocabulary and reading comprehension.

The staff attempted to ascertain the appropriate content and difficulty level for test material from analysis of textbooks and interviews. Then the tests were tried out on students who varied in ability and amount of course work. These test results were analyzed to find the adequacy of test development and to show which tests needed improvement.

Distributions of test scores were graphed for students with more or less experience. Tests were intended to show successful students getting a high percentage of the items correct. This left most of the score range to show deficiencies of poorly prepared students.

In other words, the staff attempted to develop tests with negatively skewed distributions. Any other shaped distribution shows that test revision was necessary.

Item analyses were conducted to show which items were functioning properly and to show how others could be improved. These showed which items were too easy or too difficult to differentiate among students. They also showed which items differentiate students who had learned the basic skills from those who hadn't. For multiple-choice tests, they showed which alternatives aided in the differentiation and which were either ignored or added confusion. Craig Mueller became proficient at using item analysis data to improve test items.

Examinations for basic skills in three course areas have been completed and revised. The project has developed tools that are useful in identifying students who can benefit from remedial training. It would be possible to establish cutoff scores to define which students would get special help. Another possibility is that every student who shows a problem area would receive help even when as little as one-half hour is needed to correct the deficiency.

One objective of this project was to select students with deficiencies for study. They were to be given remediation over an extended period and followed up to see its results. However, for these students who were already enrolled, remediation was effected quickly on specific deficits and the students blended in to larger population. The skills tests show great promise for pinpointing student deficits that need to be treated.

The project staff intends to review the test results for a broader range of students when it can be administered to persons before they enroll. They will continue evaluation of the tests at that time. However, the present form of the tests will provide valuable information about student skills without further revision.

In my judgement these tests have shown themselves to be valuable in measuring basic skills needed for technical courses. They should help to prepare students with skills deficits to succeed in these courses.

In addition, the work in this project serves as a model for basic skills testing in other courses. I believe it would be valuable to compare the findings of this project at RVTI with the situation in similar schools. The basic skills required for a given course may or may not be similar from one school to another. These tests may be useful in other locations in their present or a somewhat modified form.

My conclusion is that the objectives of the project are sound and that the staff has done a good job in carrying them out. The main objective is finding out what a student needs to learn before teaching begins. This is so beautifully simple and straightforward that one wonders why it isn't an integral part of every teaching situation. To the credit of the RVTI staff it is becoming a part of their program.

The project staff has employed sound procedures in identifying and developing measures for basic skills for a course of study.

They are keeping an open mind in seeing how they can improve on their present products and how they can best be used in the total educational program.

Respectfully submitted,

Charles B. Schultz
Olympia, Wash.
(206) 753-5389

NAME ______________________________

ADDRESS ____________________________

PHONE ________________ DATE ______

Office
Occupations
Skills
Test

RENTON VOCATIONAL-TECHNICAL INSTITUTE

OFFICE OCCUPATIONS: ENGLISH

Parts of Speech

A part of speech is listed in front of the following sentences. The number following the part of speech tells you how many times that part of speech appears in the sentence. Underline the word or words in the sentence that represent that part of speech.

Example: Adjective (2) The accounting instructor wore a turtleneck sweater.

1) Noun (2) They conducted research and published their findings.

2) Conjunction (1) Once a month he receives a cable or notice from his bank.

3) Adjective (3) He told us to buy a fine-point pen with red or yellow ink.

4) Pronoun (3) He explained that we had thirty minutes to finish it.

5) Adverb (2) The second-year students finished their bookkeeping assignment slowly and carefully.

6) Verb (2) /We believe English and math are necessary skills.

7) Preposition (3) In the front of the classroom, Mrs. Speil lectured to the class.

8) Conjunction (3) She says I can neither type nor take shorthand, but I can lead discussion.

9) Adverb (2) Mr. Joyce usually arrives at nine, but he is already ten minutes late.

10) Adjective (1) Yesterday I used that electric typewriter.

11) Noun (2) Several students have not finished the coursework.

12) Preposition (2) During our lunch-break we walked across the parking lot.

13) Verb (2) Mr. Burton graded our papers and gave them back to us.

14) Pronoun (1) They could not take the test today.

II Capitalization

In the following sentences draw a line beneath the small letter that should be capitalized.

1) the address the invoice was sent to was sears, roebuck and co., braxton building, midtown, wisconsin.
2) mr. cook, who lectures at kingston college, wrote two articles titled, "accurate typing" and "secretarial careers".
3) during world war II, stranton technical institute was built.
4) we have exams scheduled for the first friday of december, but steve believes they will be cancelled.
5) the ibm selectric is used in all business classes except accounting 100.

III Parts of a Sentence

Underline the Subject of the following sentences:

1) Mrs. Tower is our typing teacher for spring semester.
2) The duplicator is located in the back of the classroom.
3) Three instructors developed the exam.

Underline the Complete Predicate of the following sentences.

4) Different forms are required for different correspondence.
5) In front of the blackboard stood our typing teacher.
6) Form letters are often used by our company.

Underline the Direct Object of the following sentences:

7) Mrs. Gross teaches English and math at City Vocational School.
8) She gave a smile but remained silent.
9) Using open punctuation, she wrote a letter to ACME Storage.

IV Punctuation

Put in the proper punctuation for each of the following sentences: (comma, apostrophe, quotation marks, periods, question mark, exclamation point).

1) Mrs Millers typewriter isnt working but she believes it will be repaired by next week
2) Yes accounting not only benefits businessmen creditors government agencies and managers but the housewife as well
3) If the business world continues to change with the times what must you do to keep pace
4) because we didnt know the address Mrs Benson told us that Washington Craftsman a new school was located at 7744 Belair Ave Spokane Washington
5) Are you practicing your shorthand so youll be able to pass Mr Davis test
6) You Can Always Take It With You is the title of our Spring play
7) Unbelievable Why should you be excused from the exam
8) Mrs Stay said Type 70 words per minute and you will be considered for the job
9) He was of course the last to arrive and the first to leave
10) It was Miss Wright our teacher who yelled Watch out
11) Have you decided how many courses you will be taking next semester

V Word Usage

In each of the below parentheses are listed two words. Underline the word you would use in completing the sentences.

Example: (He, They) have a poor attendance record.

1) (Its, It's) now eleven o'clock and time for lunch.
2) I have typed the letter and (went, gone) home.
3) The timewrites seem easy for (us, we) students.
4) Even though the students have not (eaten, ate) their lunch, the class has (began, begun) on time.
5) Rather (than, then) giving me the project, Mr. Tufts gave it to her.
6) The dog, (which, who) is in front of the building belongs to him.
7) She gave John and (I, me) the first two weeks to present our project, but (who's, whose) responsible for the next two weeks?
8) If that calculator and typewriter (don't, doesn't) work, use the machines in the storeroom.
9) (Your, You're) the best typist in the class.
10) Soon after, (he, him) and (she, her) began attending classes.
11) The student body (are, is) prepared to vote on the matter.
12) The teacher has (spoke, spoken) about this subject before.
13) There are (to, too) many mistakes in this report.

VI. Spelling

There are 20 misspelled words in this letter. Find the misspelled words and write them, correctly spelled, on the lines provided.

Mr. John J. Jones
ABC Company
1234 First Avenue South
Wilson, Washington 98199

Dear Mr. Jones:

The personel department within your Corperation informed me of its entention to form a clerical position in the vocational facualty. Attached for your reveiw is a copy of my personal qualification statment. I have asked my present empolyer, the Department of Business, Univercity of Washington, to send you a letter of recomendation. You should receive this letter within a few days.

I was told that the position will be filled by a flexable and reliable person. I am fourty years of age with twelfe years of experience in the occupation of Clerk-Typist. Dutys have been assigned to me that are similer to those listed in your job discription. They range from developing oporations for a procedurs manual, to supervising a student/teacher comparisen study.

If you consider me as eligable, I am available for interview at your convenience. My telephone number is 876-1246.

Yours truely,

________ ________ ________ ________

________ ________ ________ ________

________ ________ ________ ________

________ ________ ________ ________

________ ________ ________ ________

VII. Vocabulary

Twenty-five words are listed below. For each word select another word or group of words meaning about the same thing from the choices provided. Place your selection on the blank behind each word.

1. replica ___
   a) reposses
   b) copy
   c) verify
   d) reduce

2. achieve ___
   a) accomodate
   b) assimilate
   c) advocate
   d) accomplish

3. alignment ___
   a) a tax
   b) an arena
   c) an adjustment
   d) a controversy

4. meticulous ___
   a) beautiful
   b) careful
   c) delightful
   d) painful

5. deficit ___
   a) shortage
   b) rejection
   c) obstruction
   d) reduction

6. prerequisite ___
   a) prepared without delay
   b) pointed outward
   c) prolonged indefinitely
   d) required beforehand

7. ascribe ___
   a) avoid
   b) combine
   c) assign
   d) plan

8. allocate ___
   a) to set apart for a particular purpose
   b) to settle an argument
   c) to change
   d) to form an opinion

9. collateral ___
   a) security
   b) distortion
   c) balance
   d) cooperation

10. procrastinate ___
    a) solve
    b) cry
    c) delay
    d) change

11. depreciation ___
    a) a solution to a problem
    b) a share in the ownership
    c) a necessary risk
    d) a decrease in value

12. cite ___
    a) knock down
    b) quote
    c) believe
    d) place

13. astute ___
    a) hateful
    b) clever
    c) offensive
    d) brave

14. void ___
    a) useless
    b) flexible
    c) reliable
    d) careless

15. concede ___
    a) yield
    b) represent
    c) reveal
    d) calculate

16. discrepancy ___
    a) inference
    b) perseverence
    c) affluence
    d) difference

17. reciprocate ___
a) give in return
b) restrain an action
c) try in vain
d) deliver an announcement

18. adjacent ___
a) immoral
b) satisfactory
c) nearby
d) usable

19. unanimous ___
a) of no practical use
b) in complete agreement
c) in great demand
d) of extreme difficulty

20. devise ___
a) acquire
b) reject
c) prepare
d) revive

21. encumbrance ___
a) agenda
b) hindrance
c) scarcity
d) compromise

22. columnar ___
a) not strictly accurate
b) wedged into place
c) changed in structure
d) shaped like a column

23. revise ___
a) release
b) alter
c) refrain
d) authorize

24. dissipate ___
a) disprove
b) resolve
c) scatter
d) continue

25. remuneration ___
a) announcement of importance
b) settlement of a dispute
c) payment for work or service
d) abandonment of a right or title

VIII Reading

Read each section carefully, then answer the questions that appear at the end of that section. Circle the letter of the correct answer for each question.

Section I: History of the Typewriter

The story of the development of the typewriter, that remarkable instrument which has brought about such a change in business procedures, in the status of women in business, and in the teaching of business subjects, began in 1714. On January 17 of that year, Queen Anne granted a patent to Henry Mill, an English engineer, for a machine that would "impress and transcribe letters singly or progressively one after another." The first typewriter to be patented in the United States was invented by William Austin Burt of Mount Vernon, Michigan, in 1829. The reason for Burt's invention was necessity, as is so frequently the case. He had a great deal of paper work to get through, so he invented a writing machine. Ingenious as the machine was, it had one serious flaw. It was slightly slower in operation than writing with a pen.

Soon after the granting of Burt's patent, other writing machines were invented at a brisk pace. In fact, Christopher L. Sholes of Milwaukee was the fifty-second man to invent a typewriter. Sholes had read an article about the writing machine invented by John Pratt of Centre, Alabama. At this time Sholes was 48 years old and was a Collector of Customs, a legislator, and a postmaster. He was a hobbyist, as well, and was engaged at the time in the invention of a page-numbering machine. When Sholes told his fellow hobbyists about the article he had read, they assured him that his current invention was quite similar to a writing machine and suggested that he make one that would print words as well as figures. Sholes agreed and succeeded in building such a model in 1867 and an improved version in 1868. The 1868 model was the first practical typewriter to be patented.

In 1872, after countless improvements in the typewriter mechanism, the original arrangement of letters on the keyboard was changed by Sholes and Densmore from one according to the letter of the alphabet to one of greater convenience. Both men were experienced printers, and they decided to arrange the keyboard according to the principle of the printer's case (the trays holding the individual letters which were set by hand). This arrangement of the keys was dropped, however, as the letters of the alphabet were juggled around from one location to another in an effort to keep the keys from clashing and becoming stuck at the point of printing. Sholes experienced great difficulty in developing a keyboard that provided freedom of action. After the rearranged keyboard, there remained only two more really basic changes in the construction of the typewriter: the shift key in 1878 and the front stroke in 1893.

Questions:

1. The first practical typewriter to be patented was built in:
   a) 1872
   b) 1868
   c) 1867
   d) 1829
2. Besides the rearrranged keyboard, what were the other basic construction changes of the typewriter?
   a) addition of number and shift keys
   b) addition of number keys and front stroke
   c) addition of the shift key and front stroke
   d) addition of punctuation and shift keys
3. Which of the below does not describe Christopher Sholes?
   a) He was a legislator.
   b) He invented a page-numbering machine.
   c) He was the fiftieth man to invent a typewriter.
   d) He was an experienced printer.
4. Which of the below is true regarding the typewriter developed by Sholes and Densmore?
   a) the keyboard provided freedom of action
   b) the letters of the keyboard were often juggled around
   c) the typewriter could print words and page numbers, but not numbers
   d) Sholes and Densmore's original arrangement of the keyboard has remained virtually unchanged
5. The major problem with the first writing machine to be patented in the United States was
   a) a person could write faster with a pen than type with the machine
   b) the machine could not type numbers
   c) at the time it was invented, there was really no need for it
   d) the keys kept sticking at the point of printing.

Section II: History of Typewriting Instruction

The beginning of formal typewriting instruction in schools has been claimed by the Packard School in New York City, but the records of the Herkimer County Historical Society give this honor to the Scott-Browne School, New York City, in 1878. In any case, the early methodology was made up of trial-and error techniques involving the use of two fingers on each hand, and each typist made his own assignment of finger to key.

The first practical exponent of touch typewriting, the use of all fingers without looking at the keys, was Frank McGurrin of Salt Lake City, although a similar proposition had been made by Mrs. L. V. Longley of Cincinnati. Mrs. Longley, the head of a stenographic school, had long advocated the use of all fingers, although she was indifferent to the placement of the typist's eyes. McGurrin, in 1878, was inspired to teach himself to type without looking at the keys and by using all his fingers upon hearing that such a feat had been accomplished by a girl typist. McGurrin challenged all comers and remained the undefeated champion of his day.

While Frank McGurrin used the touch method himself as early as 1878, the system was not officially advocated as a method of class instruction until eleven years later, when Bates Torrey published "A Manual of Practical Typewriting" and described the method as a touch system. Following the publication of Torrey's manual in 1889, the idea grew rapidly and the method became solidly entrenched in the East. The impetus for touch typewriting in the Middle West was provided by O. P. Judd, the manager of the Remington office in Omaha, Nebraska. Judd persuaded A. C. Van Sant and F. W. Mosher to use the system, and in 1900 Van Sant spoke before the National Commercial Teachers Federation on the merits of the touch system. Following this talk and a demonstration of what his students could do as a result of such training, the touch system began to sweep the country.

Typewriting instruction, whether touch or sight, four-finger or eight-finger, remained on an individual basis. The typewriters were there; the students sat down and practiced; and if there happened to be a teacher, his official function was to check the papers. There was some group instruction in 1905; but the idea did not become popular until 1916, when World War I increased the demand for trained typists. As a result of this need, large classes were organized; but the instruction was given by court reporters and stenographers with a complete ignorance of teaching methods and a complete lack of teaching ability. This horrendous state of affairs was made worse by the drafting of elementary teachers into the field, teachers with some knowledge of teaching methods but with no knowledge or ability with respect to the typewriter.

In spite of a lack of skilled teaching personnel, there could be seen a certain trend toward a systematic approach to the study of typewriting by 1900. This approach concerned itself primarily with the keyboard, and teachers became aware of different methods of learning the keyboard and the importance of correct habit formation. This emphasis was followed by an interest in the building of skill and, finally, in the application of that skill to office problems.

The original emphasis was on keyboard mastery; and the early attempts followed the mental, or conscious memorization, approach. From 1900 to 1930, a number of memorization devices were presented. These devices centered around the use of a certain finger for certain keys, the most universal method being presented in 1910. This method emphasized the home-key positions of a and ;, and was later expanded to include the home row approach. By 1920, keyboard fingering became standardized, with the right thumb used for the space bar and with each finger assigned a certain diagonally arranged group of keys.

Questions:

1. Who was the person who first brought the idea of touch typing to the Middle West:

   a) O. P. Judd
   b) Frank McGurrin
   c) Bates Torrey
   d) A. C. Van Sant

2. Group instruction in learning how to type became popular because of:

   a) the touch typing method
   b) the need for typists during World War I
   c) the book "A Manual of Practical Typewriting"
   d) the National Commercial Teachers Federation

3. According to available records, formal instruction in how to type began in

   a) the Packard School
   b) the L. V. Longley Stenographic School
   c) the Herkimer County Stenographic School
   d) the Scott-Browne School

4. The systematic approach to the study of typewriting, developed around 1900, was originally concerned with:

   a) building of skills
   b) keyboard mastery
   c) applying learned skills to office problems
   d) standardizing keyboard fingering

5. When formal typewriting instruction first began, students were taught to type with:

   a) one finger on each hand
   b) four fingers on each hand
   c) two fingers on each hand
   d) three fingers on each hand

Section III: History of Typewriting Textbooks

The first textbook in typewriting instruction seems to be the "Handbook of Instruction for the Type Writer", written by Edward F. Underhill and published in 1880. Mrs. Longley, the first all-finger advocate, published her new method in 1882, calling it Type-Writer Lessons, the second typewriting textbook to be published. One of the first textbooks to emphasize a successful method of teaching the keyboard was Rational Typewriting", published by the Gregg Publishing Company, and based on the Cutler manuscript, "New Idea in Teaching Touch Typewriting."

The early writers ot typewriting textbooks were teachers and owners of private business colleges, such as Mrs. M. V. Longley and Curtis Haven, who wrote materials in order to have something with which to teach. Also, many business college instructors wrote texts to be used only in their own schools. Books published by the Pierce School such as the

"Pierce Manual for the Typist, and published in 1895, 1900, 1908, 1914, and 1937, were of this type. After the 1920's, this emphasis on authorship of typing texts by business college instructors began to decline and, since 1940, has virtually disappeared.

With the decline of texbooks written by private business college teachers, those written by college and university professors began to dominate the field. Beginning in 1902, with Altmaier, who was the first college teacher to publish a typewriting textbook, the importance of textbooks written be college men has increased rapidly. At the present time, contributions of this group equal those of all other groups combined.

The first books of typewriting instruction were mainly keyboard fingering manuals and often consisted only of lists of words with the proper fingering indicated above them, much as the fingering is indicated on piano exercises. An important part of many textbooks of the '80's was a "compendium" or series of 100 to 200 actual business letters. No instructions were included for the proper typing of these letters, but students were instructed to use them for study after dictation and for shorthand practice. Around 1920, this practice of providing supplementary materials of the general information type began to subside, and most textbooks now stress the "how" rather than the "what" of the content of application exercises.

The question of length of the typewriting course has gone through three stages: an era from 1880 to 1900 where no set time was given for the completion of the course; a period extending from 1900 to 1930 in which lessons were developed and course lengths varying from 50 periods to 240 periods were suggested; and the period since 1930 in which a trend toward standardization has occurred, with books for 150 periods having been most numerous. Books for 225 to 300 periods, however, have made considerable gain since 1929. The predominant plan of current textbooks is to provide 150 lessons for one-year courses, 300 lessons for two-year courses, and 225 lessons for three-semester courses.

Early books in typewriting were designed for anyone who wanted to learn to type and usually were for self-instruction purposes. Those texts which appeared around 1900 were, for the most part, designed for business college use, although they were used by other schools as well. In 1916, however, a high school text appeared, the 1916 edition of 'Rational Typing", by SoRelle and Cutler. From this time on, high school texts have increased in number and importance. In the 1920's, texts indirectly mentioning the collegiate level began to appear, but a special book for teaching typewriting in college did not appear until 1930.

Questions:

1. The first college teacher to publish a textbook about typewriting was:

   a) Longley
   b) Altmaier
   c) Haven
   d) Underhill

2. The first textbook, specially designed to teach college typewriting, appeared in:

   a) 1920
   b) 1916
   c) 1902
   d) 1930

3. Which of the below is not true about early typewriting textbooks? They usually were:

   a) keyboard fingering manuals
   b) designed for self-instruction
   c) written by college professors
   d) composed of lists of words

4. Typewriting texts written around 1900 were usually designed for use in:

   a) high schools
   b) colleges and universities
   c) business colleges
   d) private industry

5. Which textbook was known for its successful method of teaching the keyboard?

   a) New Idea in Teaching Touch Typewriting
   b) Handbook of Instruction for the Type Writer
   c) Pierce Manual for the Typist
   d) Rational Typewriting

OFFICE OCCUPATIONS: MATH

NOTE: Show all work in the space provided for each question.

1. ABC Moving Co. bought 5 new trucks at $14,067.61 each. What was the total price of the five trucks?

2. Office Occupations at Glacier Technical School has 45 students in Accounting 210, 73 in Typing 100, 13 in Beginning Shorthand, 21 in Business Math, and 37 in Business English. How many students are enrolled in Office Occupations?

3. Write in percentage form:

a) fifteen percent ____________

b) one hundred and twenty-five percent ____________

c) six percent ____________

4. ABC Company received $1,946,358.98 for services rendered. Expenses totaled $996,514.99. What was ABC Company's profit?

5. a. $2.34\overline{)10.2024}$

b.
$$\begin{array}{r} .791 \\ .038 \\ .560 \\ +\ 1.003 \\ \hline \end{array}$$

c. .756 - .3952

d.
$$\begin{array}{r} .756 \\ \times .27 \\ \hline \end{array}$$

6. Write in decimal form:

a) fifteen hundredths ____________

b) sixty-one thousandths ____________

7. Change the following fractions to decimals:

a) 4/16 ____________

b) 3/6 ____________

c) 9/12 ____________

d) 4/5 ____________

8. Change the following decimals to percent:

a) .255 ____________

b) 1.37 ____________

c) .06 ____________

d) .6 ____________

9. Four IBM Selectric typewriters were sold to a firm for $3960.40. The salesman who sold the typewriters was paid a 5% commission. How much did the salesman earn on the sale?

10. Helen typed 70 wpm Monday, 67 wpm Tuesday, 81 wpm Wednesday, 73 wpm Thursday, and 69 wpm Friday. What is her average wpm for the five days?

11. Change the following percents to decimals:

a) 6% ____________

b) 51% ____________

c) 300% ____________

d) 14.4% ____________

12. Five new typewriters cost $1,243.97, $983.25, $879.21, $868.67 and $754.53. What was the total price of the typewriters?

13. Add, multiply or divide:

a) $1.85 x.60

b) 7356 812 +8941

c) 3461 x23

d) $36\overline{)6768}$

14. Find the total of these numbers:

86.211, 49.2, .8366, 566.12 and 16.364

15. Throughout the state there are 3770 students enrolled in Office Occupations. It is expected that 20% will receive an "A". What is the total amount of students expected to get an "A"?

16. Perform the necessary calculations:

a) $\begin{array}{r} .327 \\ \underline{x.302} \end{array}$ b) 1867-549 c) $\begin{array}{r} .409 \\ \underline{+.761} \end{array}$ d) $\begin{array}{r} 1.297 \\ \underline{-.998} \end{array}$

---

17. A farmer bought 360.73 acres for $85,132.28. How much did he pay per acre?

---

18. The average milk production for Bell Farms is 6,213 gallons per month. What is the production for a 12 month period?

How many gallons does each cow produce a month if there are 57 cows?

---

19. Look over the following numbers:

.7430, 743.0, 7.430, 74.30, and 7430.

a) Which number is the third largest? ______

b) Which number is the smallest? ______

---

20. Change the following fractions to percents:

a) 3/4 ______

b) 3/5 ______

c) 1/10 ______

d) 6/6 ______

---

21. What is thirty-five percent of 63.80?

---

22. A salesman has charged $27.13, $13.43, $57.75, $25.79, $18.95 and $19.18 to his expense account. What are his total expenses?

23. Perform the necessary calculations:

a) $34,071.81
- 17,798.99

b) $36.40
x 4.35

c) $704.09
+ 395.91

24. The total weight of 13 typewriters is 494 lbs. What is the average weight of each typewriter?

25. Write out in words:

a) 30.01 ____________________

b) 621.013 ____________________

26. Place the following numbers in order starting with the largest and ending with the smallest:

.0173, 1.73, .173, .00173, and 17.3

largest   smallest

______ ______ ______ ______ ______

27. Mr. Blake's balance sheet is out of balance. The credit column totals $16,380.07 and the debit column totals $21,097.30. How far out of balance is Mr. Blake's balance sheet?

28. Six adding machines were repaired for costs of $18.50, $2.36, $10.01, $24.74, $15.42, and $5.41. What was the average repair cost?

29. Round off to the nearest thousandth:

a) .7913 __________

b) .3466 __________

c) .9894 __________

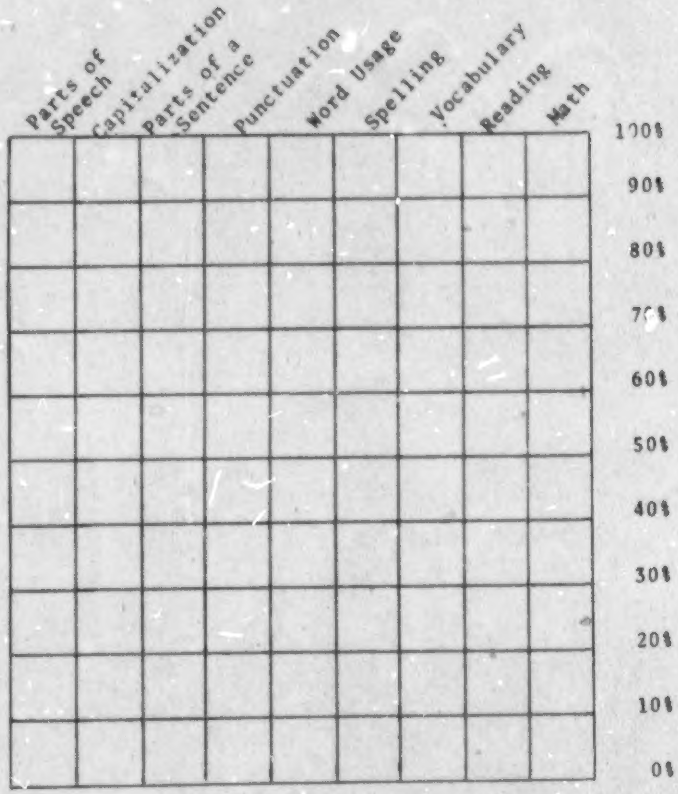
d) .1379 __________

30. a) $\begin{array}{r} .639 \\ -.321 \\ \hline \end{array}$ b) $15.50\overline{)6200}$ c) $\begin{array}{r} .36 \\ \times .9 \\ \hline \end{array}$

d) $\begin{array}{r} 13,870 \\ -\ 9,665 \\ \hline \end{array}$

---

31. Last year 18,608 persons attended vocational schools throughout the Northwest. This year the enrollment is 24,536. How many more people are attending vocational schools this year than last year?



SKILLS LIST: ENGLISH

Identifying Parts of Speech

1 Nouns
2 Pronouns
3 Adjectives
4 Verbs
5 Adverbs
6 Prepositions
7 Conjunctions

Capitalization

8 First word of every sentence
9 Brand names
10 Building names
11 Business firms
12 Days, months
13 Historical events, periods, documents
14 Institutions
15 People
16 School terms
17 Title of publications
18 Places

Identifying Parts of Sentence

19 Subject
20 Object
21 Predicate

Punctuation

22 Use of comma
   a) Separate words & numbers in a series
   b) Set off an appositive
   c) After a dependent clause at the beginning of a sentence

Punctuation (cont'd

   d) Before quotations
   e) With addresses & dates
   f) Set off such words as "of course, indeed, for instance, moreover, no doubt"
   g) After introductory words which are separated from the rest of the sentence
   h) Before a coordinating conjunction in a compound sentence
23 Quotation marks
24 Apostrophe
25 Period
26 Question mark
27 Exclamation point

Word Usage

28 Correct use of pronouns
29 Similar sounding words
30 Correct use of verbs

Spelling

31 Common words (20 words)

Vocabulary: Meaning of Words

32 Approximate meaning (synonym) (25 words)

Reading

33 Comprehension

SKILLS CHECK LIST

Parts of Speech

1 ☐☐☐☐
2 ☐☐☐☐
3 ☐☐☐☐
4 ☐☐☐☐
5 ☐☐☐☐
6 ☐☐☐☐☐
7 ☐☐☐☐

Capitalization

8 ☐☐☐☐☐
9 ☐
10 ☐
11 ☐
12 ☐☐
13 ☐
14 ☐
15 ☐☐
16 ☐☐
17 ☐☐
18 ☐☐

Parts of a Sentence

19 ☐☐☐
20 ☐☐☐
21 ☐☐☐

Punctuation

22a ☐
b ☐☐
c ☐☐
d ☐☐

Punctuation (cont'd)

22e ☐
f ☐
g ☐
h ☐
23 ☐☐☐
24 ☐☐☐☐☐
25 ☐☐☐☐☐☐☐☐☐☐☐☐
26 ☐☐☐☐
27 ☐☐☐

Word Usage

28 ☐☐☐☐☐☐☐
29 ☐
30 ☐☐☐☐☐☐

Spelling

31 ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Vocabulary

32 ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Reading

33 ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

COMMENTS:

ANSWER AND SKILL SHEET FOR OFFICE OCCUPATIONS: ENGLISH

		Answer	Skill/Frequency
I	1)	research, findings	1/2
	2)	or	7
	3)	fine-point, red, yellow	3/3
	4)	He, we, it	2/3
	5)	slowly, carefully	5/2
	6)	believe, are	4/2
	7)	In, of to	6/3
	8)	neither, nor, but	7/3
	9)	usually, already	5/2
	10)	electric	3
	11)	students, coursework	1/2
	12)	During, across	6/2
	13)	graded, gave	4/2
	14)	They	2
II	1)	the, sears, roebuck and co., braxton building, midtown, wisconsin.	8, 11, 10, 18/2
	2)	mr. cook, kingston college, "accurate typing", "secretarial careers".	8, 15, 16, 17/2
	3)	during, world war II, stranton technical institute	8, 13, 14
	4)	we, friday, december, steve	8, 12/2, 15
	5)	the, i b m selectric, accounting	8, 9, 16
III	1)	Mrs. Tower, 2) duplicator 3) three instructors	19/3
	4)	are required for different correspondence. 5) In front of the blackboard stood 6) are often used by our company.	21/3
	7)	English & math 8) smile 9) letter	20/3
IV.	1)	Mrs. Miller's, isn't, working, week.	25, 24, 24, 22h, 25
	2)	Yes, businessmen, creditors, government agencies, managers, well.	22g, 22a, 25
	3)	times, pace?	22c, 26
	4)	didn't address, Mrs. Craftsman, school, Ave., Spokane, Washington	24, 22c, 2[illegible], 22b, 25, 22e, 25
	5)	you'll Mr. Davis' test?	24, 25, 24, 26
	6)	"You Can Always Take It With You" play.	23, 25
	7)	Unbelievable! exam?	27, 26
	8)	Mrs. said, "Type... job."	25, 22d, 23, 25
	9)	was, course, leave.	22f, 25
	10)	Wright, teacher, yelled, "Watch out!"	22b, 22d, 23, 27
	11)	semester?	26
V.	1)	It's	30
	2)	gone	30
	3)	we	28
	4)	eaten, begun	30/2
	5)	than	29
	6)	which	28
	7)	me, who's	28/2
	8)	doesn't	30
	9)	You're	28
	10)	he, she	28/2
	11)	is	30
	12)	spoken	30
	13)	to	29
VI.		personnel, Corporation, intention, faculty, review, statement, employer, University, recommendation, flexible, forty, twelve, Duties, similar, description, operations, procedures, comparison, eligible, truly	33/20
VII.		1-b, 2-d, 3-c, 4-b, 5-a, 6-d, 7-c, 8-a, 9-a, 10-c, 11-d, 12-b, 13-b, 14-a, 15-a, 16-d, 17-a, 18-c, 19-b, 20-c, 21-b, 22-d, 23-b, 24-c, 25-c.	34/25
VIII.		Section I; 1-b, 2-c, 3-c, 4-b, 5-a Section II: 1-a, 2-b, 3-d, 4-b, 5-c Section III: 1-b, 2-d, 3-c, 4-c, 5-d	

ANSWER AND SKILL SHEET FOR OFFICE OCCUPATIONS: MATH

Number	Answer	Skill/Frequency
1	$70,338.05	39
2	189	34
3	a) 15% b) 125% c) 6%	50/3
4	$949,843.99	37
5	a) 4.36 b) 2.392 c) .3608 d) .204120	47, 44, 45, 46
6	a) .15 b) .061	42/2
7	a) .25 b) .50 c) .75 d) .80	43/4
8	a) 25.5% b) 137% c) 6% d) 60%	51/4
9	$198.02	54
10	72 wpm	41
11	a) .86 b) .51 c) 3.00 d) .144	52/4
12	$4729.63	35
13	a) $1.11 b) 17.109 c) 79,603 d) 188	39, 34, 38, 40
14	718.7316	44
15	754.00	54
16	a) .098754 b) 1,318 c) 1.170 d) .299	46, 36, 44, 45
17	$236	47
18	74,556 109	38, 40
19	a) 74.30 b) .7430	48/2
20	a) 75% b) 60% c) 10% d) 100%	53/4
21	$22.33	54
22	$162.23	35
23	a) $16,272.82 b) $158.34 c) $1100.00	37, 39, 35
24	38 lbs	40
25	a) Thirty and one-one hundredth b) Six hundred twenty-one and thirteen thousandths	42/2
26	17.3, 1.73, .173, .0173 .00173	48
27	$4,717.23	37
28	$76.44	35
29	a) .791 b) .347 c) .989 d) .138	49/4
30	a) .318 b) 400 c) .333 d) 4205	45, 47, 46, 36
31	5,928	36

OFFICE OCCUPATIONS SKILLS LIST: MATH

Basic Calculations

34 Addition of whole numbers

35 Addition of money: dollar sign and decimal point

36 Subtraction of whole numbers

37 Subtraction of money using dollar sign and decimal

38 Multiplication of whole numbers

39 Multiplication of money using dollar sign and decimal point

40 Division of whole numbers

41 Computing averages

Decimals

42 Reading and writing decimals as numbers and words

43 Fraction to decimal

44 Addition of decimals

45 Subtraction of decimals

46 Multiplication of decimals

47 Division of decimals

48 Comparing decimals

49 Rounding Off

Percents

50 Reading and writing percents

51 Decimal to percent

52 Percent to decimal

53 Fraction to percent

54 Solve for part

Mechanics and Directions

55 Mechanics and Directions

SKILLS PROFILE

Basic Calculations

34			
35			
36			
37			
38			
39			
40			
41			

Decimals

42				
43				
44				
45				
46				
47				
48				
49				

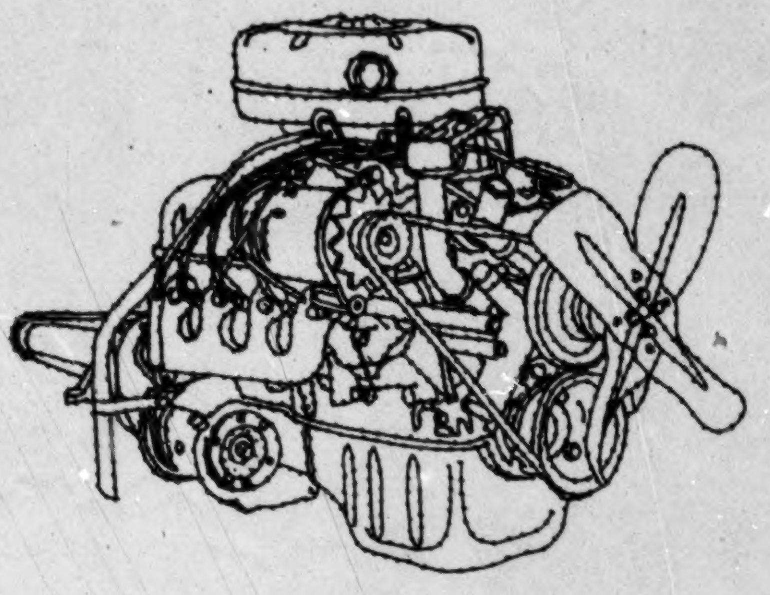
Percents

50				
51				
52				
53				
54				

Mechanics and Directions

Comments:

NAME ______________________________
ADDRESS ______________________________
PHONE NO. ______________



AUTOMOTIVE MECHANICS

RENTON VOCATIONAL TECHNICAL INSTITUTE

I Reading

Read each section carefully, then answer the questions that appear at the end of that section. Circle the letter of the correct answer for each question.

Section I: The Automobile and Automotive Industry

Perhaps the first "automobile" propelled by a gas engine was made in 1863. It had a one-cylinder engine using lighting gas (not liquid gasoline) as fuel. The French inventor, Lenoir, actually drove it 6 miles. Much experimental work went on during the next few years, both on engines and on the carriages, or bodies, in which they could be mounted. By 1855 Daimier and Benz, in Germany, had built vehicles that ran on liquid fuel similar to gasoline. In the early 1890's, the French firm of Daimier and Panhard began the manufacture of automobiles with the engine in front and with a transmission and drive chain that carried the power to the rear wheels.

The first successful American car was built by the Duryea Brothers (Charles and Frank) in Massachusetts in 1893. Other American inventors were soon experimenting and building their own versions of the "horseless carriage". By 1896, Henry Ford, Ransom Olds, Alexander Winton and Charles King had built automobiles that ran more or less successfully. Much of this work was done in and around Detroit, Michigan.

By 1900, several factories had been set up in Detroit and elsewhere to make automobiles. Two of the most important ideas that early inventors and manufacturers developed were interchangeability and mass production.

Interchangeability of parts was a relatively new idea in 1900. Before then, many of the individual parts for machines were more or less handmade. Each was different from the others, and each part had to be hand-fitted to the machines. This was a long and costly process, and when the part wore out a new one had to be made by hand.

The new idea was to make parts identical to each other. Thus, all pistons and other parts for a particular type of engine were made to be as nearly alike as possible. Screws, nuts, washers, and other such parts were standardized. All this required precision machinery that could turn out thousands of identical parts. Then, when an engine was being assembled, it was not necessary to fit each part separately.

Everything would go together with a minimum of special fitting work.

Along with interchangeability came the idea of mass production. If all parts were made to be interchangeable you would not have to stop to fit each part to the machines. The job of building an engine, for example, was simplified to the point of merely installing the parts onto or into the engine block. Later came the idea of having the assemblers stand in one place as the machine being assembled was moved along on a conveyor belt. Henry Ford was the first automotive manufacturer to use the conveyor belt. In 1913, he developed an assembly line in which the automobile frame was pulled along on a conveyor and workmen on both sides attached parts to it. These parts were fed to the workmen by secondary conveyors. This reduced assembly time for an automobile from a day and a half or two days to less than two hours. Furthermore, it now became possible for thousands of cars to come off the end of an assembly line every day.

Questions:

1. Lighting gas was used as a fuel for the automobile invented by
   a) Daimier
   b) King
   c) Lenoir
   d) Panhard
2. What contribution did Henry Ford make to the automobile industry?
   a) He invented a gasoline engine.
   b) He made parts identical to each other.
   c) He introduced the conveyor belt.
   d) He developed a special automobile frame.
3. Before 1900 individual machine parts
   a) required precision machinery
   b) were fitted with a minimum of special fitting work
   c) were similar to one another
   d) were made one at a time
4. Two developments, brought about by early manufacturers, that greatly changed the automobile industry were
   a) building automobiles with the engine in front and rear-wheel drive.
   b) the assembly line and new factories
   c) the horseless carriage and development of automobile factories
   d) mass production and interchangeability
5. Who built the first successful American car?
   a) Ransom Olds
   b) Henry Ford
   c) Charles and Frank Duryea
   d) Charles King

Section II: Holley Carburetor Company

From its very beginnings, Holley Carburetor Company combined an intense interest in auto racing with a dedication to engineering excellence. Founded in 1902 by the Holley brothers of Bradford, Pennsylvania, the company as we know it 70 years later grew out of their experiments with the infant horseless carriage.

At the age of 19, George M. Holley designed and built his first car, - a single-cylinder three-wheeler capable of 30 miles per hour. Fascination with speed and things mechanical soon led young Holley into motorcycle racing at which he excelled in national competition. Together with his brother Earl, they formed Holley Brothers to build motorcycle engines when they were not racing. Later, they built entire motorcycles.

This unique combination of talents led to still another original vehicle which has long since disappeared from the auto scene, - the Holley Motorette. Introduced in 1903, this jaunty little candy-apple-red sports model sold for $550 - fully equipped. More than 600 of the 5.5 HP vehicles were built over a three year period. There are just three of these original cars in existence - one is in the Holley lobby in Warren, Michigan.

By this time the fledgling auto industry was taking shape and the first hint of industrial specialization began to emerge. Sensing this trend, the owners of Holley elected to concentrate on designing and building carburetors and ignition-system components for car makers such as Pierce-Arrow, Winton, Buick, and Ford. They left the building of the basic vehicle to their customers and became original equipment suppliers.

Their first original carburetor, called the "iron pot", appeared on the curved-dash Olds in 1904. Today, Holley carburetors can be found on Chrysler, Ford, General Motors, International Harvester, White, Mack, Diamond Reo and other vehicles as well as some very exotic specialized applications such as the Corvett LT-1 and the Camaro Z-28. Holley ignition distributors have been standard equipment on thousands of vehicles built by International Harvester, Ford and others.

Questions:

1. Holley Brothers was originally formed to build
   - a) automobiles
   - b) carburetors
   - c) motorcycle engines
   - c) a three-wheeled vehicle
2. The owners of Holley concentrated on manufacturing carburetors
   - a) to supply Chrysler, Ford and General Motors
   - b) because the Holley Motorette proved to be underpowered
   - c) as the industrial specialization began
   - d) in 1903
3. Approximately how many Holley Motorettes were produced?
   - a) 3
   - b) 30
   - c) 550
   - d) 600
4. The Holley lobby is located in
   - a) Bradford, Penn.
   - b) Warren, Mich.
   - c) Detroit, Mich.
   - d) Boston, Mass.
5. What was known as the iron pot?
   - a) The 1904 curved-dash Olds.
   - b) The first carburetor that Holley made.
   - c) The three-wheeler designed and built by George Holley.
   - d) The motorcycle engine made by Holley Brothers.

Section III: Electricity

Up until about 1600 A.D., just a little over 375 years ago, there was no formal knowledge of electricity as such. There were only bits and pieces of information - an odd collection of disconnected observations and theories.

A shepherd who lived in Asia Minor more than 5000 years ago had stumbled on a piece of stone which had the peculiar power to attract iron. We know, of course, that this was a natural magnet, but at that time it was regarded as just an amusing curiosity. Several hundred years laters, it was discovered that one end of a magnet always pointed to the North. The ancient Chinese were the first to take advantage of this knowledge by using the magnet as a compass to help them find their way across the great wastes of the Gobi Desert.

And it wasn't until some 4000 years after the first natural magnet was discovered, that someone noticed that the North-seeking end of one magnet attracted the South-seeking end of another magnet - and that the North-seeking ends (or the South-seeking ends) repelled each other!

In the meantime, a Greek philosopher had discovered that if he rubbed a piece of amber with felt, the amber would attract straws, dried leaves, and other light objects. And, at about the same time, another Greek came up with the theory that all matter was made up of tiny particles which he named "atoms." And that was about it.

Then, around the year 1600, Sir William Gilbert, an English physician and physicist, gathered all available information together, did some experimentation of his own, and wrote a series of books on the subject of "Electricity," a name which he borrowed from the Greek word elektron, meaning amber.

In 1660, a German physicist named Otto von Guericke built the first static generator and proved that electricity could be generated. He discovered that electricity could be made to travel to the end of a thread. And he also discovered that all "charged" bodies had properties similar to those of magnets: that "like" charges repelled each other, and "unlike" charges attracted each other.

These discoveries by von Guericke led to a number of other experiments and theories about electricity.

In 1752, Ben Franklin flew his famous kite and proved that lightning is a form of electricity. He also established a theory about the nature of electricity which provided a big breakthrough in understanding the "why" of electricity. Franklin believed that electricity existed in two different forms: Postive and negative - and it was this theory which proved to be the foundation of many more experiments which led to our present day knowledge of electricity.

Thanks to atomic research in the field of chemistry and physics, we now have an established, understandable basis on which to start our study of electricity, the Electron Theory. When you come to understand this comparatively simple theory, you'll find that your knowledge of electricity can grow logically - step by step - because most of the mystery of electricity will be cleared up and the door will be wide open for its mastery.

We still don't know everything about electricity, but we do know how it works and how to use it - that's the important thing!

Questions:

1. The first known use of a magnet was

   a) to find iron
   b) as a compass
   c) to produce electricity
   d) to attract light objects

2. Which of the below established a theory about electricity which became the foundation of our present day knowledge of electricity?

   a) Gilbert
   b) Guericke
   c) Greek philosophers
   d) Franklin

3. Formal knowledge of electricity began

   a) more than 5000 years ago
   b) more than 1600 years ago
   c) about 375 years ago
   d) about 4000 years ago

4. Electricity comes from a Greek word meaning

   a) lightning
   b) amber
   c) attract
   d) charges

5. When magnets were first discovered they were regarded as

   a) amusing curiosities
   b) having supernatural power
   c) atoms
   d) iron

11. Vocabulary

Twenty-five words are listed below. For each word select another word or group of words meaning about the same thing from the choices provided. Place your selection on the blank behind each word.

Example:
deficit ___
a) shortage
b) rejection
c) obstruction
d) compromise

1. abrasive ___
a) light used for reading
b) material used for grinding
c) liquid used for lubricating
d) instrument used in soldering

2. counter ___
a) swollen
b) hollow
c) opposite
d) traditional

3. variance ___
a) frequence
b) difference
c) independence
d) resemblance

4. combustible ___
a) feasible
b) reversible
c) extendible
d) inflammable

5. dense ___
a) compact
b) uneven
c) harsh
d) precise

6. taper ___
a) reduce gradually
b) change in appearance
c) clamp tightly
d) convert consistently

7. approximate ___
a) nearly equal
b) carefully compared
c) normally prepared
d) almost complete

8. displace ___
a) discourage
b) balance
c) remove
d) control

9. inhibit ___
a) restrain
b) extinguish
c) introduce
d) select

10. agility ___
a) nimbleness
b) carelessness
c) fondness
d) foolishness

11. appraisal ___
a) strain
b) compound
c) valuation
d) agreement

12. pertinent ___
a) persistent
b) noxious
c) intentional
d) relevant

13. retract ___
a) agree
b) grasp
c) withdraw
d) fold

14. ream ___
a) enlarge
b) rotate
c) disengage
d) file

15. adjacent ___
a) exclusive
b) confident
c) nearby
d) continual

16. universal ___
a) general
b) unquestionable
c) spiritual
d) successive

17. prerequisite ___
   a) announce early
   b) require beforehand
   c) advance forward
   d) receive afterwards

18. reciprocate ___
   a) express an opinion
   b) resolve an argument
   c) break into pieces
   d) give in return

19. fluctuate ___
   a) disagree
   b) change
   c) regulate
   d) sweep

20. periodic ___
   a) pertaining to the neck
   b) requiring much labor
   c) appearing at regular intervals
   d) affecting a part

21. distribute ___
   a) stretch
   b) obtain
   c) withdraw
   d) allot

22. excessive ___
   a) correction
   b) advantage
   c) surplus
   d) maximum

23. radiate ___
   a) fine in texture
   b) change in some way
   c) diminish in strength
   d) spread out from a center

24. defective ___
   a) fragile
   b) imperfect
   c) defiant
   d) careless

25. conventional ___
   a) avoiding waste
   b) having much energy
   c) conforming to accepted standards
   d) treating someone or something with respect

AUTOMOTIVE MECHANICS: MATH

Note: Show all work in the space provided for each question.

1. A customer had his car tuned-up and was charged \$9.53 spark plugs, \$2.47 points, \$1.95 condenser, \$8.34 spark plug wiring, and \$37.16 labor. What was the customer's total bill?

---

2. Perform the necessary calculations:

a) $\frac{3}{8} + \frac{4}{8}$ b) $\frac{10}{10} - \frac{7}{10}$ c) $\frac{8}{16} + \frac{5}{16}$ d) $\frac{23}{27} - \frac{8}{27}$

---

3. If a car gets 16.7 miles per gallon, how far can it travel on 13.5 gallons of gas?

4. Look over the following numbers:

.8560, 856.0, 8.560, 85.60, and 8560

What is the difference between the two largest numbers?

What is the sum of the largest and smallest numbers?

---

5. Reduce these fractions to lowest possible terms:

a) $\frac{6}{9}$ b) $\frac{15}{27}$

c) $\frac{13}{16}$ d) $\frac{8}{10}$

---

6. Steve bought a Corvette with a standard 275 horsepower engine. He replaced several standard parts with parts designed to increase horsepower and speed. Steve's engine is now rated at 360 horsepower. How many horsepower did he gain?

7. Perform the necessary calculations:

a) $\frac{3}{12} \times \frac{6}{7}$

b) $\frac{3}{32} \div \frac{6}{12}$

c) $\frac{4}{5} \times \frac{11}{16}$

d) $\frac{15}{64} \div \frac{3}{8}$

---

8. Change the following to percents:

a) .250 ________

b) 3.96 ________

c) .03 ________

d) .4 ________

9. A mechanic, checking the gaps of two spark plugs, found one gap to be .032 and the other to be .046. What is the difference between the two sparkplug gaps?

---

10. Five race cars were tested for horsepower ratings at 10,000 rpm (revolutions per minute). The test showed that the first car developed 525 horsepower, the second 492, the third 467, and fourth 513, and the fifth 498. What was the total horsepower developed by the five cars?

---

11. Perform the necessary calculations:

a) $\begin{array}{r} 639 \\ \underline{\times 105} \end{array}$

b) $\begin{array}{r} 1631 \\ 274 \\ 2703 \\ \underline{+\ 98} \end{array}$

c) $\begin{array}{r} 9,475 \\ \underline{-8,069} \end{array}$

d) $208\overline{)19344}$

12. Forty percent of a $63.50 bill was for labor. How much was the customer charged for labor?

---

13. The crankshaft of an engine revolved 71,812 times during a 13 minute period of time. How many revolutions per minute did the crankshaft revolve?.

---

14. Perform the necessary calculations:

a) .639 - .543

b) .67 + .278 + .8

c) .911 x .420

d) $.759\overline{).72864}$

15. Automotive Repair and Co. bought 13 new engines at $339.40 apiece. What was the total price of the 13 engines?

16. Perform the necessary calculations:

a) $$\begin{array}{r} \frac{4}{10} \\ +\frac{9}{20} \\ \hline \end{array}$$

b) $$\begin{array}{r} \frac{4}{5} \\ -\frac{2}{3} \\ \hline \end{array}$$

c) $$\begin{array}{r} \frac{4}{8} \\ +\frac{2}{4} \\ \hline \end{array}$$

d) $$\begin{array}{r} \frac{9}{14} \\ -\frac{2}{7} \\ \hline \end{array}$$

17. Write out in words:

a) .613 ____________________

b) 15.93 ____________________

c) .1476 ____________________

18. A shop received a shipment of 160 coils of electrical wire. Fifty-five percent of the coils will be used to rewire shop tow trucks. How many coils of electrical wire will it take to rewire the tow trucks?

19. Steve bought five wide oval tires at a wholesale price of $43.62 per tire. How much did he pay for the tires?

20. Place the following numbers in order, starting with the largest and ending with the smallest.

.396   3.96   .0396   39.6   .00396

______   ______   ______   ______   ______

21. Perform the necessary calculations:

a) .742 x .53

b) 1.2 - .638

b) .9193 + .080

d) $58\overline{)1.856}$

---

22. Perform the necessary operations:

a) $\frac{3}{10} \times \frac{7}{8}$

b) $\frac{1}{6} \div \frac{1}{3}$

c) $\frac{15}{24} \times \frac{7}{16}$

d) $\frac{5}{8} \div \frac{3}{4}$

23. Change the following fractions to percents:

a) $\frac{3}{5}$

b) $\frac{7}{14}$

c) $\frac{6}{10}$

d) $\frac{16}{16}$

---

24. When Tom checked the air pressure of his car's tires, he found them all to be low. He had to add 4.5 p.s.i. (pounds per sq. inch) and 1.6 p.s.i. to the front tires, and 10 p.s.i. and 6.3 p.s.i. to the rear tires. What is the total amount of pounds per square inch that Tom had to add to his tires?

---

25. What is the average of the following figures?

87, 28, 3, 41, 106 65

26. Convert the following fractions to decimals:

a) $\frac{3}{4}$ ______________________

b) $\frac{3}{10}$ ______________________

c) $\frac{8}{16}$ ______________________

d) $\frac{8}{8}$ ______________________

---

27. Perform the necessary calculations:

a) $\begin{array}{r} \$103.76 \\ +\ 898.24 \\ \hline \end{array}$

b) $21\overline{)\$203.07}$

c) $\begin{array}{r} \$48.50 \\ \times\ 13.04 \\ \hline \end{array}$

d) $\begin{array}{r} \$\ 1,934.16 \\ -\ \ 841.05 \\ \hline \end{array}$

---

28. A customer received a bill of $311.64 for work done on his car. After checking each expense listed on the bill, he found he was overcharged $13.84. What should the customer actually have been charged?

29. Cleaning solvent comes in 5.5 gallon containers. In a six month period, an auto shop used 66 gallons of solvent. How many containers of cleaning solvent were used in the six month period?

---

30. When Jerry checked the brake fluid level of three cars, he found each car needed fluid. He added 5/16 of a pint to the first car, 2/16 of a pint to the second and 6/16 of a pint to the third. How much brake fluid did Jerry need?

31. Workers on an assembly line can assemble 5.3 cars in an hour. At this rate, how many cars can be assembled in 8.5 hours?

32. A salesman drove his car 333.70 miles on 14.2 gallons of gasoline. How many miles per gallon did he get on his car? Carry your answer out to tenths.

33. An auto shop serviced 31 cars. Total amount of money received for servicing these cars was $2518.13. What was the average service charge for the 31 cars?

34. Change the following percents to decimals:

a) 150% ____________________

b) 33% ____________________

c) 7% ____________________

d) 14.5% ____________________

35. Perform the necessary calculations:

a) $\frac{7}{8} - \frac{2}{8}$

b) $\frac{8}{24} + \frac{13}{24}$

c) $\frac{6}{7} - \frac{4}{7}$

d) $\frac{13}{64} + \frac{21}{64}$

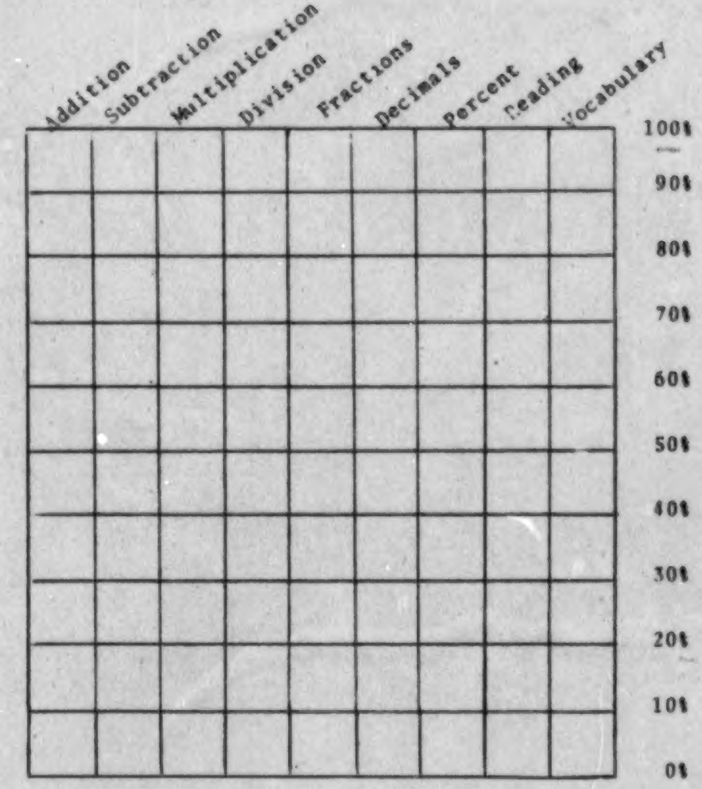
36. Round to the nearest hundredth:

a) .8163 ____________________

b) .5658 ____________________

c) .432 ____________________

d) .7918 ____________________


Addition
Subtraction
Multiplication
Division
Fractions
Decimals
Percent
Reading
Vocabulary
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

SKILLS LIST FOR AUTOMOTIVE MECHANICS: MATH, READING, VOCABULARY

Basic Computations

1 Addition of whole numbers

2 Addition of money: dollar sign and decimal point

3 Subtraction of whole numbers

4 Subtraction of money using dollar sign and decimal

5 Multiplication of whole numbers

6 Multiplication of money using dollar sign and decimal point

7 Division of whole numbers

8 Division of money using dollar sign and decimal point

9 Computing averages

Fractions

10 Addition of fractions

11 Subtraction of fractions

12 Multiplication of fractions

13 Division of fractions

14 Reducing fractions

15 Unlike fractions

16 Fractions to decimals

17 Fractions to percent

Decimals

18 Reading and writing decimals as numbers and words

19 Addition of decimals

20 Subtraction of decimals

21 Multiplication of decimals

22 Division of decimals

23 Comparing decimals

24 Rounding off

25 Decimal to percent

Percentage

26 Percent to decimal

27 Percent of a total

Reading

28 Comprehension

Vocabulary

29 Approximate meaning (synonym)

Mechanics and Directions

30

SKILLS PROFILE

Basic Computations

1			
2			
3			
4			
5			
6			
7			
8			
9			

Fractions

10					
11					
12					
13					
14					
15					
16					
17					

Decimals

18				
19				
20				
21				
22				
23				
24				
25				

Percentage

26				
27				

Reading

28															

Vocabulary

29																

Mechanics and Directions

30										

ANSWER AND SKILL SHEET FOR AUTOMOTIVE MECHANICS: MATH, READING, VOCABULARY

Number	Answer	Skills/Frequency
1	$59.45	2
2	a) 7/8 b) 3/10 c) 13/16 d) 5/27	10/2. 11/2
3	225.45 miles	21
4	7704 8560.8560	23/2 20, 19
5	a) 2/3 b) 5/9 c) 13/16 d) 4/5	14/4
6	85	3
7	a) 3/14 b) 3/16 c) 44/80 or 11/20 d) 5/8	12/2, 13/2
8	a) 25% b) 396% c) 3% d) 40%	25/4
9	.014	20
10	2495 hp	1
11	a) 67095 b) 4706 c) 1,406 d) 93	5,1,3,7
12	$25.40	27
13	5524	7
14	a) .096 b) 1.748 c) .382620 d) .96	20, 19, 21, 22
15	$ 4412.20	6
16	a) 17/20 b) 2/15 c) 8/8 or 1 d) 5/14	15/4
17	a) six hundred thirteen thousandths b) fifteen and ninety-three hundredths c) one thousand four hundred seventy-six ten thousandths	18/3
18	88	27
19	$218.10	6
20	39.6, 3.96, .396, .0396, .00396	23
21	a) .39326 b) .562 c) .9993 d) .032	21, 20, 19, 22
22	a) 21/80 b) 1/2 c) 105/384 d) 5/6	12/2, 13/2
23	a) 60%, b) 50% c) 60% d) 100%	17/4
24	22.4 p.s.i.	19
25	55	9
26	a) .75 b) .30 c) .50 d) 1.00	16/4
27	a) $1002.00 b) $9.67 c) $632.44 d) $1,093.11	2, 8, 6, 4
28	$297.80	4
29	12	22
30	13/16	10
31	45.05	21
32	23.5	22
33	$81.23	8
34	a) 1.50 b) .33 c) .07 d) .145	26/4
35	a) 5/8 b) 21/24 c) 2/7 d) 34/64 or 17/32	10/2, 11/2
36	a) .82 b) .57 c) .43 d) .79	24/4

READING:

Section I: 1-c, 2-c, 3-d, 4-d, 5-c
Section II: 1-c, 2-c, 3-d, 4-b, 5-b
Section III: 1-b, 2-d, 3-c, 4-b, 5-a

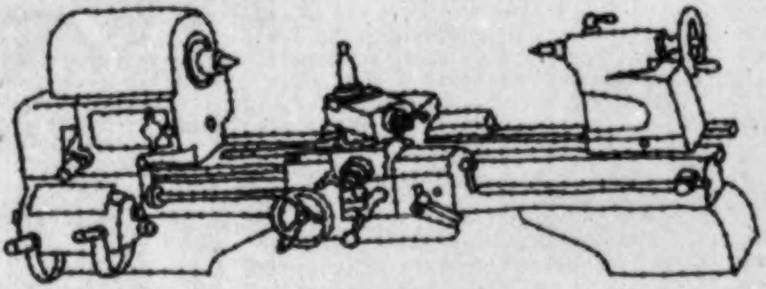
VOCABULARY:

1-b, 2-c, 3-b, 4-d, 5-a, 6-a, 7-a, 8-c, 9-a, 10-a
11-c, 12-d, 13-c, 14-a, 15-c, 16-a, 17-b, 18-d, 19-b,
20-c, 21-d, 22-c, 23-d, 24-b, 25-c

NAME ______________________________

ADDRESS ____________________________

PHONE ____________



MACHINE SHOP

RENTON VOCATIONAL TECHNICAL INSTITUTE

I Reading

Read each section carefully, then answer the questions that appear at the end of that section. Circle the letter of the correct answer for each question.

Section I Apprenticeship: First Legislation

The first legislation in the United States to promote an organized system of apprenticeship was enacted in Wisconsin. In 1915 this State passed a law placing apprenticeship under the jurisdiction of an industrial commission. The law followed the enactment of a State law requiring all apprentices to attend classroom instruction five hours a week.

Apprenticeship on a national scale in the United States has been a natural outgrowth of an increasing need for skilled workers of which the Nation as a whole became keenly aware, as never before, during the boom days following World War I. Due to the reduction of immigration after that war and the reduction in the number of skilled workers coming from other countries, the need for training of apprentices throughout the Nation became a vital necessity.

The decade beginning in 1920 saw a planned effort for a national, uniform system of apprenticeship, begun by national employers, labor organizations, educators, and government officials - Federal, State, and local, and the construction industry which was in the forefront of this movement.

The combined effort on the part of the various interests in all industries led to the participation in 1934 of the Federal Government in the promotion of apprenticeship on a national basis. That year the Federal Committee on Apprenticeship was appointed by the Secretary of Labor to serve as the national policy-recommending body on apprenticeships in the United States. This committee was originally created to assume the responsibilities with respect to apprentices and their training under industrial codes formulated by the National Recovery Administration.

In 1937 the National Apprenticeship Law was passed by Congress. This law, popularly known as the Fitzgerald Act, was enacted "to promote the furtherance of labor standards of apprenticeship.

As a result of this act, the Federal Committee on Apprenticeship was reorganized and enlarged to include an equal number of representatives of employers and labor, in addition to a representative of the U.S. Office of Education. Also, Apprentice-Training Service (now known as the Bureau of Apprenticeship and Training) was established as the national administrative agency in the Labor Department to carry out the objectives of the law in conformance with the policies determined by the Federal Committee. For the guidance of employers and labor, this committee has recommended certain fundamentals to follow in setting up apprenticeship programs.

A major factor in the promotion of apprenticeship has been the spread and exchange of information on the advantages of well-organized, efficiently conducted, comprehensive programs and on the latest and most successful training methods and procedures. Widespread exchange of this information among employers and labor in different industries and localities has been through newspapers and industrial periodicals, discussion at annual conventions of employer associations and unions, and to a very large extent through multi-State apprenticeship conferences. These multi-State conferences are held annually on the Eastern Seaboard and in the Southern States, periodically in the Western States. The first multi-State apprenticeship conference, which was held in Bethel, Maine, in 1945, was initiated and planned by a member of the Bureau of Apprenticeship and Training.

That employers and labor have cooperated in carrying out the Federal legislation is indicated by the fact that over 6,000 joint apprenticeship committees had been established by 1963. In addition to these, national trade committees have been created, each of which is equally representative of national employer and labor organizations. The national committee members are officially appointed by the Secretary of Labor. These national committees function in a promotional as well as policy-making capacity in the trades they represent. They develop with the assistance of the Bureau of Apprenticeship and Training, national standards of apprentice training for the guidance of local employer and labor groups.

Questions:

1) The first known multi-State apprenticeship conference came about due to the efforts of a person who was a member of the:

   a) Federal Committee
   b) Employer Association
   c) Labor Council
   d) Bureau of Apprenticeship and Training

2) The Fitzgerald Act was also known as the

   a) National Recovery Law
   b) Wisconsin State Law
   c) National Apprenticeship Law
   d) Apprentice-Training Law

3) Which of the factors listed below is an important reason for the increased need for apprenticeship training after World War I.

   a) the decisions made by the industrial commission
   b) support for apprenticeship from the Federal Government
   c) reduction of immigration
   d) assumption of apprentice responsibilities by the National Recovery Administration.

4) To become a member of a national trade committee one must be appointed by:

   a) the Secretary of Labor
   b) a joint apprenticeship committee
   c) the Bureau of Apprenticeship and Training
   d) The Federal Committee

5) Around 1920, which of the below agencies was at the head of the effort to establish a national uniform system of apprenticeship.

   a) Labor Department
   b) construction industry
   c) state of Wisconsin
   d) Federal Committee on Apprenticeship

Section II Historical Background of Screw Threads

It is not known who first discovered the use of the screw thread, but it was many centuries ago, probably suggested by Archimedes (278-212 B.C.). He developed a screw which was enclosed in a cylinder for the purpose of drawing water.

During the Middle Ages, nuts and bolts were used to fasten metal suits of armor together. Such early screws were made by hand tools and were very crude. Before 1800, screws were forged to shape and the threads were layed out and filed by hand. The slots also were cut by hand with a saw. Since there were no standards concerning size or pitch, these early bolts and nuts could not be used interchangeably.

The era of interchangeability and mass production came about with the invention of the steam engine and power-driven machine tools. Henry Maudslay developed the first power-driven screw-cutting lathe in England in 1797. His lathe was equipped with a master lead screw and several changeable gears which made it possible to cut uniform threads of various size and pitch.

Throughout the 19th Century, improvements were made in the design and development of metalworking hand and machine tools. The turret lathe was developed about 1845. With improved methods of mass production came a greater demand for a standardized system of screw threads which could provide for some degree of interchangeability.

In 1841 Sir Joseph Whitworth developed a standard for screw threads in Great Britain. During the next twenty years, his standard was generally adopted in Great Britain, but not in the United States. Whitworth's original standard, with various modifications, formed the basis of the British Standard Whitworth (BSW) thread, which still is used to some extent in Great Britain. The BSW thread has a 55° V-form with rounded crests and rounded roots. Three classes of threads are included in the Whitworth Standards: they are designated as close, medium, and free fits.

The first progress toward the standardization of screw threads in the United States occurred in 1864. During that year, a committee appointed by the Franklin Institute presented a report recommending proposed screw thread standards, many of which were developed by William Sellers. The report was adopted, and the thread system became known as the Sellers Standard (later the United States Standard). Sellers accepted many of the diameter-pitch combinations of the Whitworth system, but omitted some of the sizes over 1 1/2". He also selected 13 threads instead of 12 for the 1/2" size. His thread had a 60° included angle, instead of the 55° angles used on the Whitworth thread. Hence, the Sellers thread was not interchangeable with the Whitworth thread. The 60° V-form was easier to produce and measure. Sellers modified the sharper V-form of thread which was customary at the time by utilizing flats at the crest and roots. The flats were equal to one-eighth of the pitch.

Questions:

1) The first screw thread standard adopted by the United States was known as the:

   a) Sellers Standard
   b) Maudslay Standard
   c) British Standard Whitworth
   d) Franklin Institute Standard

2) The first lathe able to cut uniform threads with different sizes and pitches was developed in the year:

   a) 1845
   b) 1841
   c) 1797
   d) 1800

3) Which of the below is true regarding the United States' and England's thread standards:

   a) The two thread standards were interchangeable with each other.
   b) The U. S. standard called for a thread angle of 55°, while the English standard called for 60°.
   c) The English standard was often modified by using flats equal to 1/8 the pitch.
   d) The U. S. thread standard was easier to measure than England's thread standard.

4) The demand for a standardized system of screw threads came about due to:

   a) the development of a lathe with several changeable gears
   b) the invention of the turret lathe
   c) the need for interchangeability
   d) the work of Sir Joseph Whitworth

5) Which of the below is not true regarding screws made before 1800:

   a) a handsaw was used to cut the screw slots
   b) they could be used interchangeably
   c) most screws were shaped by forging
   d) the threads were filed by hand

Section III The Warner & Swasey Company

In 1880 two young machinists, Worcester Reed Warner and Ambrose Swasey, decided to leave the Pratt & Whitney shops in Hartford, Connecticut, to open a small plant of their own. In doing this, they felt that they should go west, so they established their first shop and obtained their first order in Chicago. This order was for twelve "hand" lathes, but within the first year they had designed and built turret lathes.

A year later, in 1881, they moved their plant to Cleveland, Ohio, and from that time until today that plant has concentrated on the design and manufacture of turret lathes. The original machine was quite simple but was basically the same turret lathe as is produced today. It had a cone-driven spindle in the center and a turret at the right. All things considered, it was a remarkable machine for its time. The three-step cone gave it three different speeds and there was a reversing countershaft for forward and reverse. Coolant dripped from a can above the machine and was caught in another can below. Bearings were of the plain type, and the entire machine was of very simple design.

Developments and additions to this machine were made continually. By 1900 the standard turret lathe had back gears to provide speed changes by simply moving a clutch lever, power feed to the turret to take cuts under power, and in 1912 the universal cross slide was introduced. As these developments were going on, better cutting steels were being developed. These steels made it possible to cut material faster and take heavier cuts.

Since World War I, the greatest improvement in turret lathe operation has resulted from increased power and speed built into the machines. For example, a 1 1/2" bar machine of 1914 had a 3 horsepower drive and a maximum speed of 450 rpm. By 1926 this same size machine was stepped up to 750 rpm. and supplied with a 5 horsepower motor. Ten years later the same machine was stepped up again, this time to 1500 rpm with a 7 1/2 horsepower motor.

These improvements were required to take advantage of the advances in metallurgy. New alloy steels were harder to cut and required more power to machine. On the other hand. new cutting alloys for tools made it possible to machine these tougher steels at high speeds. These tough alloy steels were in turn used to develop more powerful machines.

By the use of better materials and by further development of design principles, it has been possible to build more powerful machines without increasing their size. Thus, today the 1 1/2" bar machine is approximately the same size as the 1900 turret lathe and operates as easily in spite of the increased power developed in the machine.

Questions:

1) When was the turret lathe developed that had a maximum speed of 750 r.p.m.?
   a) 1914
   b) 1936
   c) 1926
   d) 1900

2) Over the years, the main factor that allowed improvements in turret lathes was:

a) easier cutting alloy steels
b) advances in metallurgy
c) development of design principles
d) increasing power of the machine without making it larger

3) Which of the below is a true statement regarding the orginal turret lathe built by Warner and Swasey:

a) It had a side mounted cone-driven spindle
b) The turret lathe produced today is basically the same as the original
c) The turret was in the center
d) For the times, the machine was fairly complex in design.

4) It was in Cleveland that Warner and Swasey

a) established their first shop
b) began concentrating on making turret lathes
c) decided to leave their employers and start their own small plant
d) received their first order for hand lathes

5) What part of the original machine built by Warner and Swasey was responsible for the three different speeds?

a) reversing countershaft
b) back gears
c) cone-driven spindle
d) three-step cone

II. Vocabulary

Twenty-five words are listed below. For each word select another word or group of words meaning about the same thing from the choices provided. Place your selection on the blank behind each word.

Example:
deficit a a) shortage
b) rejection
c) obstruction
d) compromise

1. vertical ___ a) sideways
b) parallel
c) angular
d) upright

2. ream ___ a) enlarge
b) disengage
c) adjust
d) measure

3. abrasive ___ a) an obstruction in a passage
b) a material used for grinding
c) a space between machine parts
d) a liquid used for lubrication

4. course ___ a) powerful
b) sensitive
c) unrefined
d) broken

5. shear ___ a) melt
b) pound
c) thread
d) cut

6. taper ___ a) decrease gradually in size
b) clamp tightly
c) change greatly
d) convert slowly

7. variance ___
   a) alignment
   b) similarity
   c) reduction
   d) discrepancy

8. retract ___
   a) continue
   b) stretch
   c) bend
   d) withdraw

9. distribute ___
   a) alter
   b) extend
   c) allot
   d) obtain

10. excessive ___
    a) rapid
    b) improper
    c) extreme
    d) responsive

11. adjacent ___
    a) permanent
    b) nearby
    c) necessary
    d) rigid

12. conventional ___
    a) conforming to accepted standards
    b) increasing in strength
    c) remaining unchanged
    d) avoiding waste

13. precise ___
    a) persistent
    b) exact
    c) superior
    d) unstable

14. fundamental ___
    a) basic
    b) pure
    c) solid
    d) strict

15. revise ___
    a) prepare
    b) restrain
    c) repair
    d) alter

16. penetrate ___
    a) bend
    b) straighten
    c) pierce
    d) curve

17. duplication ___
    a) reproduction
    b) classification
    c) rejection
    d) modification

18. reciprocate ___
    a) give in return
    b) break into pieces
    c) resolve a problem
    d) express an opinion

19. preliminary ___
    a) middle
    b) average
    c) first
    d) last

20. compound ___
    a) curved surface
    b) not very wide
    c) having two or more parts
    d) square in shape

21. flexible ___
    a) faulty
    b) relevant
    c) effective
    d) limber

22. compress ___
    a) spread
    b) seal
    c) remove
    d) condense

23. counter ___
    a) swollen
    b) opposite
    c) hollow
    d) traditional

24. universal ___
    a) general
    b) spacious
    c) special
    d) inexhaustible

25. brittle ___
    a) incorrect
    b) frequent
    c) quick
    d) fragile

III. Math

Note: Show all work in the space provided for each question.

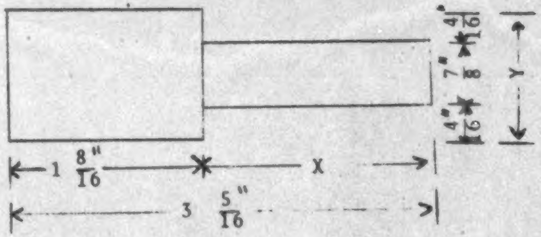
1. a) 12351 + 23 b) 373 + 5615 + 1409

c) 10,736 - 9,854 d) 926 x 53

2. a) .91 ÷ .13 b) .731 + .0823 + .269

c) 23.4785 – 13.659 d) .536 x .509

3. Find X and Y in the following diagram:



4. There are 57 shafts that each need .018 inches of material filed off. What is the total amount of material that will be filed off from the shafts?

5. Cascade Wheel has a work force of 76 men. During the month of December, Cascade Wheel was contracted to manufacture 26,828 helical gears. In order for the contract to be filled how many gears per person will Cascade Wheel have to produce?

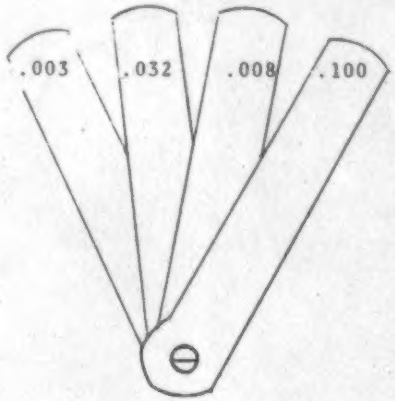
6. A drive line was made up of five parts. The tolerances for the five parts were .001, .0323, .0256, .03, and .008. What was the total amount of tolerance in the drive line?

---

7. In April, Ted produced 21,763 pieces of work. In May he produced 17,865 pieces of work. How many fewer pieces did he produce in May?

---

8. Which of the blades is the largest? ________ Smallest? ______



9. a) $2/6 + 3/6 + 5/6$ b) $7/8 - 1/4$

c) $1/4 \times 3/4$ d) $3/8 \div 5/8$

________ ________ ________

10. Olympia Tool & Die has been in operation for 5 years. The first year Olympia Tool & Die used 231 gallons of machine oil, the second year 273 gallons, the third year 196 gallons, the fourth year 177 and the fifth year, after being awarded a government contract, the company used 375 gallons. What is the total amount of machine oil used by Olympia Tool & Die during the five years it has been in operation?

---

11. Round the following decimals to the nearest thousandth.

a) .0037 ____________

b) .5899 ____________

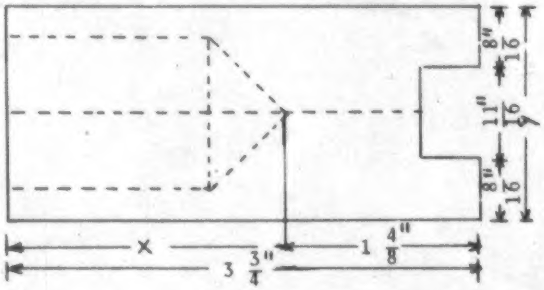
c) .3644 ____________

d) .8931 ____________

12. If 11.1129 ounces of material are removed from 17 pieces of work, what is the average amount of material removed from each piece?

---

13. Find X and Y in the following diagram:


8/16"
11/16"
8/16"
Y
X
1 4/8"
3 3/4"

14. a) .298070 ÷ .082

b) .032 x .16

c) 1.0965 − .887

d) .1078 + .398 + .6 + .45

---

15. If a machine shop can produce 469 spur gears a month, how many spur gears can be produced over a 24 month period?

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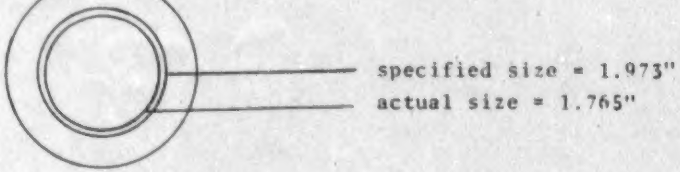
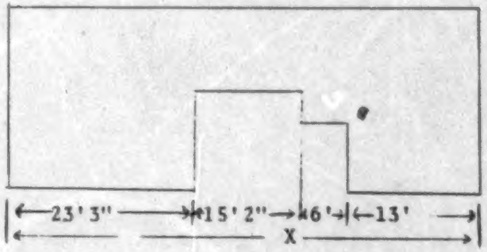
16. How much material must be removed in order for the hole to be the specified size?


specified size = 1.973"
actual size = 1.765"

17. The supply records for a machine shop showed that 1152 drills had been replaced by the supply department over a twelve month period. How many drills, on the average, must the supply department replace each month?

18. a) $1\frac{2}{3} \times 3\frac{1}{4}$ b) $6\frac{3}{10} \div \frac{9}{20}$

19. What is the length of X in the diagram:

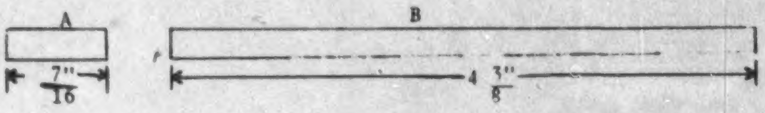


20. Place the following numbers in order starting with the smallest and ending with the largest.

.144, 14.4, .0144, 1.44, .00144

_____ _____ _____ _____ _____

21. How many lengths of Bar A can you make from Bar B?



22. a) 143,350 ÷ 305 b) 14,372 + 35,528 + 6,137

c) 629 − 437 d) 378 x 408

23. Change the following fractions to decimals:

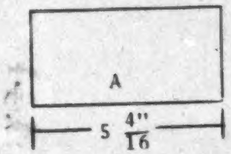
a) $\frac{4}{5}$ ____________________

b) $\frac{7}{10}$ ____________________

c) $\frac{9}{12}$ ____________________

d) $\frac{6}{6}$ ____________________

24. What would be the length of a bar 12 times the length of A?



25. A shop has received an order for 16 shafts which measure 21.43 inches a piece. Disregarding cut thickness, what is the total length of stock necessary to fill the order?

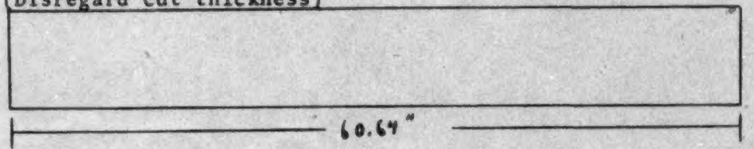
26. a) $\frac{14}{16} \div \frac{1}{2}$

b) $\begin{array}{r} 1\frac{3}{4} \\ +\frac{2}{4} \\ \hline \end{array}$

c) $\begin{array}{r} 1\frac{4}{16} \\ -\frac{9}{16} \\ \hline \end{array}$

d) $\frac{4}{5} \times \frac{4}{7}$

27. How many pieces can be cut from the stock shown below if each piece is 3.79 inches long? (Disregard cut thickness)



28. ABC Machine Shop ordered 148 steel shafts. What is the total weight of the steel shafts if each shaft weighs 9 pounds?

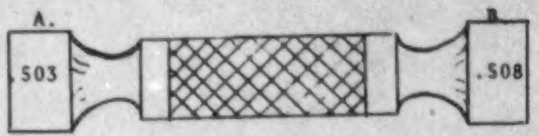
29. A machinist was squaring stock with a milling machine. He milled .0735 of an inch from one surface, .13 from another surface, and .105 from another surface. What was the total amount milled from the surfaces?

30. The new super-light lathe that Mechanical Contractors ordered weighs 1,748 pounds. The old lathe weighs 3,839 pounds. How much less does the new super-light lathe weigh than the old lathe?

31. Add:

7541 + 27 + 603 + 9

32. Which end of the plug gauge is larger?



33. How much larger in diameter is a drill that measures .9063 inches in diameter than a drill that measures .7283 inches in diameter?

34. Change the following decimals to fractions:

a) .750 ____________

b) .375 ____________

c) .875 ____________

d) .300 ____________

ANSWER AND SKILL SHEET FOR MACHINE SHOP: MATH, READING VOCABULARY

Number	Answer	Skills/Frequency
1	a) 537 b) 1343 c) 991 d) 4876	4, 1, 2, 3
2	a) 7 b) 1.082 c) 9.819 d) .272824	13, 10, 11, 12
3	X = 1 13/16" Y = 1 3/8"	6, 5
4	1.026"	12
5	353	4
6	.108	10
7	3898	2
8	Largest .100, Smallest .003	15
9	a) 5/6 b) 5/8 c) 3/16 d) 3/5	5, 6, 7, 8
10	1252	1
11	a) .004 b) .590 b) .364 d) .893	16/4
12	1.249	13
13	X = 2 2/8", Y = 27/16" or 1 11/16"	6, 5
14	a) 3.635 b) .00512 c).2095 d)1.5558	13, 12,11, 10
15	11,256	3
16	.208	11
17	96	4
18	a) 5 5/12 b) 2/3	7, 8
19	57'	1
20	.00144, .0144, .144, 1.44, 14.4	15
21	10 2/7 times	8
22	a) 470 b) 49,900 c) 192 d) 154,224	4, 1, 2, 3
23	a) .8 b) .7 c) .75 d) .25	9/4
24	63"	7
25	342.88+.25 = 343.13	12
26	a) 1 6/8 or 1 3/4 b) 3/4 c) 13/16 d) 16/35	8, 5, 6, 7
27	16	13
28	1332	3
29	.310	10
30	2,091	2
31	8180	1
32	8.508	15
33	.1780	11
34	a) 3/4 b) 3/8 c) 7/8 d) 3/10	14/4

Reading

Section I: 1-d, 2-c, 3-c, 4-a, 5-b
Section II: 1-a, 2-c, 3-d, 4-c, 5-b
Section III: 1-c, 2-b, 3-b, 4-c, 5-d

Vocabulary:

1-d, 2-a 3-b, 4-c, 5-d, 6-a, 7-d, 8-d, 9-c, 10-c, 11-b, 12-a, 13-b, 14-a, 15-d, 16-c, 17-a, 18-a, 19-c, 20-c, 21-d, 22-d, 23-b, 24-a, 25-d

SKILLS LIST FOR MACHINE SHOP: MATH, READING, VOCABULARY

Basic Calculations

1 Addition of whole numbers
2 Subtraction of whole numbers
3 Multiplication of whole numbers
4 Division of whole numbers

Fractions

5 Addition of fractions
6 Subtraction of fractions
7 Multiplication of fractions
8 Division of fractions
9 Fractions to decimals

Decimals

10 Addition of decimals
11 Subtraction of decimals
12 Multiplication of decimals
13 Division of decimals

Decimals (contd)

14 Decimals to fractions
15 Comparing decimals
16 Rounding off

Reading

17 Comprehension

Vocabulary

18 Approximate meaning (synonym)

Mechanics and Directions

19 Mechanics and directions

SKILLS PROFILE

Basic Calculations

1					
2					
3					
4					

Fractions

5				
6				
7				
8				
9				

Decimals

10				
11				
12				
13				
14				
15				
16				

Reading

17															

Vocabulary

18																									

Mechanics & Directions

19								

Comments:

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